S. HRG. 104–571

AIR BAG SAFETY

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED FOURTH CONGRESS

SECOND SESSION

MARCH 7, 1996

Printed for the use of the Committee on Commerce, Science, and Transportation

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED FOURTH CONGRESS

SECOND SESSION

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HEARING ON AIR BAG SAFETY

THURSDAY, MARCH 7, 1996

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The committee met, pursuant to notice, at 9:30 a.m., in room SR–253, Russell Senate Office Building, Hon. Larry Pressler (chairman of the committee) presiding.

Staff members assigned to this hearing: Lance D. Bultena staff counsel; and Moses Boyd, minority senior counsel.

OPENING STATEMENT OF SENATOR PRESSLER

The CHAIRMAN. I call this meeting of the Senate Commerce, Science, and Transportation Committee to order.

This morning, we are dealing with the safety of air bags. It almost seems somewhat of an oxymoron to be holding a hearing on whether air bags might do damage in some instances, but that has been the report. Our purpose today is to discuss the effectiveness of air bags, and the instances where they cause fatalities, or injuries to children or to small, elderly people, who might be holding themselves very close to a steering wheel.

In general, air bags are functioning well. They are credited with saving over 900 lives since 1987, and with reducing the severity of injury in many more instances. The Intermodal Surface Transportation Efficiency Act of 1991 required the use of both passenger- and driver-side air bags in all cars manufactured after September 1, 1997, and all light trucks and vans manufactured after September 1, 1998.

My home State of South Dakota is pickup country, so I know many folks there are watching this issue.

ISTEA also required the U.S. Department of Transportation to report to Congress every 6 months on the effectiveness of occupant restraint systems. I understand there has been some confusion over this report requirement, and that the most recent report is now over a year late. I am not saying this failure is any indication the National Highway Traffic Safety Administration mishandled the issue. I am pleased we have National Highway Traffic Safety Administrator Martinez with us today, and hope we can resolve any questions or misunderstandings that may exist.

Another purpose of today's hearing is that there is, tragically, a down side to air bag use. In some relatively rare cases, air bags cause injury. These injuries are normally minor, but sometimes the injuries have been very serious. The most publicized of the adverse

side effects of the air bags are child or infant fatalities in accidents where, absent an air bag, a fatality would not have occurred.

It seems air bags can cause injury when passengers find themselves too near the air bag when it deploys. I understand that frequently the passenger is out of position because they are not properly restrained by a seat belt, safety belt, or, in the case of infants, because they were not in a properly positioned child safety seat.

I think there may be a need to publicize the importance of putting child safety seats in the back seat, and not in a passenger seat equipped with an air bag. The motoring public must also be aware of the injuries which can occur from an air bag if the lap and shoulder belts are not fastened. I look forward to hearing from NHTSA about research being conducted to improve air bag safety, and, from all witnesses, what is being done to alert and inform the public.

In today's hearing, I hope we will learn more about the safety tradeoffs involved with air bags. I also expect we will hear testimony on the importance of wearing safety belts to both maximize the safety benefits of air bags, and minimize the risk of collateral injury.

I thank the witnesses for coming to testify today. I look forward to their remarks. I call on my colleague from the State of Nevada.

[Prepared statement of Senator Pressler follows:]

PREPARED STATEMENT OF SENATOR PRESSLER

The purpose of today's hearing is to conduct general oversight concerning the safety and effectiveness of air bags. In general, air bags are functioning well. They are credited with saving over 900 lives since 1987 and with reducing the severity of injury in many more instances.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) required the use of both passenger and driver side air bags in all cars manufactured after September 1, 1997 and all light trucks and vans manufactured after September 1, 1998. My home state of South Dakota is pickup country, so I know many folks there are watching this issue.

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Another purpose of today's hearing is that there is, tragically, a downside to air bag use. In some relatively rare cases, air bags cause injury. These injuries are normally minor but sometimes the injuries have been very serious. The most publicized of the adverse side effects of air bags are child or infant fatalities in accidents where, absent an air bag, a fatality would not have occurred. It seems air bags can cause injury when passengers find themselves too near the air bag when it deploys. I understand that frequently the passenger is out of position because they were not properly restrained by a safety belt, or in the case of infants, because they were not in a properly positioned child safety seat.

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I thank the witnesses for coming to testify today. I look forward to your remarks.

STATEMENT OF SENATOR BURNS

PREPARED STATEMENT OF SENATOR CONRAD BURNS

Chairman Pressler, one of the most important functions of this Committee is our oversight of safety issues. I appreciate your holding this hearing on air bag safety and I will keep my remarks short so we can hear more from the Witnesses.

Highway safety has been a major issue during this session of Congress. Last fall, we enacted legislation designating the national highway system. It also included provisions regarding speed limits, hours-of-service, drunk driving and motorcycle helmets. The bottom line is that many here believe that the states can handle these issues on their own. Every state has a highway department, a transportation department and a State Highway Patrol—folks who are capable of looking at their state and its condition and making a reasonable decision based on calculated facts.

We are also living in a different time than when the federal speed limits were enacted over two decades ago. Cars are safer and roads are better maintained. More people wear seatbelts—seatbelts that are better and safer than they were then. And today car buyers want safety features such as air bags, side-impact strengthened doors, and day-running lamps.

ISTEA of 1991 required all passenger cars manufactured after September 1, 1997 to have driver and passenger air bags, plus manual lap and shoulder belts. "Buckle-up" laws and increased awareness of the effectiveness of seat belts has resulted in more people—67 percent as of December 1994—buclUing up.

The federal government, in conjunction with the automobile industry, has accomplished much in making cars safer and in turn making the roads safer. More than 65,000 lives have been saved by safety belts since 1982. And airbags have saved an estimated 1,000 lives since 1987, a 20 percent reduction in driver deaths in frontal crashes.

It is clear that air bags used with safety belts effectively prevent deaths and serious injuries in front-end motor vehicle crashes. However, as with any safety device, it is not effective for every victim nor in all cases. In some cases, special precautions must be taken.

For example, NHTSA released safety recommendations regarding children and airbags in response to airbag-related fatalities and serious injuries to infant passengers. Small people are also in danger because of sitting too close to the compartment when the airbag is released. And so are people who do not have the seat belt fastened at impact.

The problem could be airbag inflators that have too high of pressure so they inflate with too much force. Crash test standards may have to be changed. On-switches have also been recommended as a way to turn off the airbag system.

I am also interested in long-term solutions like the "smart bag" that would take all of these factors into consideration and provide the best protection possible in a greater number of cases.

Mr. Chairman, I thank the witnesses for coming today and appreciate having the opportunity to hear their concerns and suggestions for improving airbag safety.

STATEMENT OF SENATOR HOLLINGS

STATEMENT OF SENATOR HOLLINGS

As a long-time supporter of highway safety programs, I have a great interest in airbag safety.

I am proud that, along with Senators Bryan and Gorton, I was a sponsor of legislation in the l02nd Congress to require the installation of airbags in passenger cars and light trucks. When that legislation was introduced, the Bush Administration and the automobile industry were opposed to it. We were successful, nevertheless, in attaching the legislation to the Intermodal Surface Transportation Efficiency Act, which was passed and signed into law in 1991.

Safety experts have recognized airbags as the single most effective device in preventing automobile related deaths and injuries. While seat belts are essential to protecting occupants in traffic accidents, airbags are considered the number one life saving device. The National Highway Traffic Safety Administration (NHTSA) estimates that airbag-equipped cars could save 9,000 lives and prevent over 150,000 serious injuries annually, as compared to automobiles without airbags.

Pursuant to the passage of the 1991 airbag legislation, car manufacturers are required to equip all passenger cars with driver and passenger side airbags by September 1997, and light trucks by September 1998. NHTSA has advised that car manufacturers are on schedule to comply with the law.

Although airbag effectiveness is undisputed, I am aware that issues have been raised about possible adverse side effects of airbags. Some, including the Ford Motor Company, have suggested that airbags may cause injuries as a result of aggressive deployment. I believe that this issue needs to be examined by the Committee, as well as NHTSA and highway safety experts. However, any changes in testing and safety standards should be studied intensely, and considered very cautiously, to ensure that airbag safety is not compromised.

I look forward to the testimony of the witnesses at today's hearing.

STATEMENT OF SENATOR RICHARD H. BRYAN, U.S. SENATOR FROM NEVADA

Senator BRYAN. Mr. Chairman, thank you very much.

Let me preface my remarks by congratulating you on convening this timely hearing on the issue of auto safety.

If I may, I would like to make just a few opening comments.

I think that if one looks over the last two decades, improvements in automobile safety have been nothing short of remarkable. Today we travel millions of miles more than we did a decade ago, and yet auto fatalities are down—particularly down in the context of the number of fatalities and accidents involving the number of miles that we travel.

Air bags have played an important part in improved auto safety. The technology developed in the 1950's. It took us three decades in the Congress, with bipartisan support, I note, Mr. Chairman. Senator Slade Gorton, Senator Fritz Hollings, who was then the chairman of this committee, and I, labored mightily to enact that legislation.

Having said that, I fully acknowledge that there have been legitimate concerns raised about the deployment of air bags, particularly with youngsters, and particularly when there is a failure to use the seat belt system as well. So I look forward to hearing the comments and testimony this morning.

Clearly, public education is a part of the message that we need to communicate to the public. The notion that somehow air bags render the use of seat belts unnecessary, to the extent that that information is out there, is a false message when it comes to auto safety. I note that the automobile industry, to its credit, is prepared to put forward a substantial amount of money on a matching basis, up to $10 million as I am informed, to help to carry out that message.

I must say that I am disappointed that the insurance industry, which has a vested interest in auto safety, has to date apparently not been willing to make a commitment. I would hope that we would hear from representatives of the industry, and encourage them to make that commitment.

The bottom line from this Senator's perspective is that we need to move very carefully on changing any standards. The worst thing that we could do would be to change the standards and have a net increase of fatalities and serious accidents, again, not to underestimate the fact that there may be an issue out here that we need to address and to take a look at. But I look forward, Mr. Chairman, with you and other members of this committee, to hearing the testimony this morning.

And, again, I congratulate you on convening this hearing.

The CHAIRMAN. We will now hear from the Hon. Ricardo Martinez, Administrator, National Highway Traffic Safety Administration. Thank you very much.

STATEMENT OF RICARDO MARTINEZ, M.D., ADMINISTRATOR, NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION; ACCOMPANIED BY BARRY FELRICE, ASSOCIATE ADMINISTRATOR FOR SAFETY PERFORMANCE STANDARDS; WILLIAM BOEHLY, ASSOCIATE ADMINISTRATOR FOR RESEARCH AND DEVELOPMENT; JIM HEDLUND ASSOCIATE ADMINISTRATOR FOR TRAFFIC SAFETY PROGRAMS; AND SAM DUBBIN, CHIEF COUNSEL

Dr. MARTINEZ. Thank you, Mr. Chairman and members of the committee, Mr. Bryan.

Thank you for the invitation to appear before you today to testify on the effectiveness of air bags with our experience to date. With me today are Barry Felrice, our Associate Administrator for Safety Performance Standards;

William Boehly, our Associate Administrator for Research and Development; Jim Hedlund, our Associate Administrator for Traffic Safety Programs; and Sam Dubbin, our Chief Counsel.

The hearing process presents an opportunity to reemphasize the significance of motor vehicle crashes in the overall injury problem in the United States of America. It also enables us to portray the complexity of the problem and the tradeoffs that prospective solutions raise.

Motor vehicle crashes continue to take the lives of thousands of Americans every year; 41,700 in 1995. That is over 113 people every day, 113 people today. Crashes are the leading cause of death for persons between the ages of 5 and 27 years old in this country. They are the leading cause of head injuries for all age groups. Head injuries, in turn, are the leading cause of fatalities in motor vehicle crashes.

The air bag is one of the most advanced safety devices ever to be installed in motor vehicles. It offers a combination of reliability and effectiveness in high-speed crashes, and it works automatically.

To offset the violent forces of a crash, the air bag has to be incredibly quick—faster than the blink of an eye. The typical air bag deploys in 25 milliseconds, that is one-fourth of a tenth of a second, and provides protection that allows the occupant to decelerate gradually.

These characteristics have made the air bag an object of interest to our agency, the motor vehicle manufacturers, and the general public for many years. This interest, along with regulatory incentives, has led the manufacturers to install air bags throughout the new car fleet.

In the current model year, driver-side air bags are installed in virtually all new passenger cars, well ahead of the schedule called for by regulation. Installation of front passenger air bags is also increasing rapidly.

To ensure full installation of air bags, Congress directed the agency to require air bags for the front seating positions in all passenger cars by model year 1998, and in all light trucks by model

year 1999. Indications are that the manufacturers will reach 100 percent installation before the required dates.

Today, there are 35 million cars and light trucks with driver-side air bags, and about 12 million also have passenger-side air bags, of that 35 million. The numbers are increasing rapidly.

Now that there are so many air bag-equipped vehicles in the fleet, we are beginning to get enough data to evaluate the air bag effectiveness in real-world crashes. We can make some statements with confidence.

Air bags are reducing fatalities. NHTSA estimates that air bags have saved about 1,500 lives since 1987, with an estimated 570 lives in 1995 alone.

Air bags are reducing serious injuries to the head and spine. We have strong indications from our hospital studies and from our data bases that air bags are effective in reducing the severity of these often disabling injuries.

The number of lives saved and injuries prevented will increase as the number of air bag-equipped vehicles in the fleet increases. We expect that to be a dramatic increase over the years.

All of this is good news. But we also have some concerns about the adverse effects of air bags that we are now beginning to observe and understand. NHTSA has been conducting periodic reviews of air bag deployments in an effort to see how air bags are performing in actual cases. As more data became available, we began a focused, in-depth analysis of air bag performance.

At this point, our data indicate that the necessary quickness and force of the deploying air bag have some adverse effects. There are a number of injuries to arms and hands.

While not life threatening, these injuries can be serious. There is a small but significant number of fatal injuries to occupants at the extremes of age and size, most notably, as you mentioned, the elderly and the smaller children.

We have investigated 15 crashes since the late 1980's in which a child has been fatally injured by a passenger-side air bag. Of these children, four were infants riding in rear-facing infant seats, and 11 were children between the ages of 4 and 9 years old, who were either unrestrained or restrained improperly. We know of no adult fatalities associated with passenger-side air bags.

We have also investigated 20 fatalities since the late 1980's involving driver-side air bags. Of these, the majority of drivers were unrestrained or out of position. But others were small, elderly women, again. We are concerned that these numbers will increase as the number of air bags in the fleet increases unless measures are taken to intervene now.

We have already amended the occupant protection standard to permit a passenger-side cutoff switch for vehicles that do not have a rear seat large enough to accommodate an infant seat. I remind you that back in 1991 and 1992, we found a problem with the rear-facing infant seat with the passenger-side air bag. We issued a warning at that time, but also have required labels in the cars and on the child safety seat in order to decrease the incidence of that problem.

On October 27, 1995, the agency issued an emphatic warning to parents about the risk of air bags to children. We are continuing to repeat this warning.

On November 9, 1995, we issued a request for comments to obtain advice from all interested parties on ways to reduce the adverse effect of air bags. To this date, we have received 54 technical comments.

A number of comments suggest amendments to the occupant protection standard, including broader use of cutoff switches, the reduction of the amount of propellant in the bag, the reduction of the test speed for unbelted occupants in the standard, from 30 miles per hour to 25 miles per hour, and the adoption of stronger warning labels. Several commentors also pointed to the prospects of "smart" air bags that will sense out-of-position occupants and respond appropriately.

At this time, we are considering all comments in an effort to find the best way to maximize the benefits of air bags, but minimize the adverse effects. All of these proposed changes have tradeoffs, and they must be evaluated and quantified.

In the short run, we are convinced that the best way to minimize the adverse effects is to increase the use of safety belts and child safety seats, and to ensure that children ride in the back seat whenever possible. That also affects the next few years, but also the fact that we have got 35 million cars out there now that we need to do something about.

Our data from non-air bag crashes show that 72 percent——I repeat that—72 percent of children 5 to 15 years old fatally injured in the front seat are unrestrained in this country. We must do better.

To this end, we created a coalition of safety, medical and public interest groups to disseminate information on the interaction of air bags with unrestrained children and on rear-facing seats. We have a series of alert notices that we sent out, brochures, newsletters, everything else, to try to get this information out to practitioners—over 200 groups. We are enlisting the support of manufacturers and insurers to expand that effort and to increase the rate of safety belt use throughout the country. This will benefit the occupants of all vehicles, not just those with air bags.

We are also considering regulatory changes. But the comments made clear that these issues are very complicated. The tradeoffs of the proposed changes have not been quantified as of this date, but we are working with researchers, engineers, and others to do so as quickly as possible.

As part of considering any change to protect children, for example, we must be able to quantify the effects of the change on all occupants. Our legislative mandate is to improve safety for all occupants, and we really intend to do that. In the long run, appropriate steps to address these adverse effects will enable the air bag to fulfill its lifesaving promise as a key element of a vehicle's occupant crash protection system.

We are happy to be here today to answer any questions that we can for the committee, and hope that this hearing will increase the awareness in the general public, and are happy to come back at any time to give you more information.

[The prepared statement of Dr. Martinez follows:]

STATEMENT OF RICARDO MARTINEZ, M.D., ADMINISTRATOR NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Mr. Chairman and Members of the Committee: Thank you for your invitation to appear before you today to testify on the effectiveness of air bags. With me today are Barry Felrice, our Associate Administrator for Safety Performance Standards, William Boehly, our Associate Administrator for Research and Development, Jim Hedlund, our Associate Administrator for Traffic Safety Programs, and Sam Dubbin, our Chief Counsel.

We appreciate the opportunity to discuss the effectiveness of air bags and the safety considerations involved in the National Highway Traffic Safety Administration's (NHTSA) present air bag regulations.

To begin, I would first like to explain briefly what happens in a motor vehicle crash and why air bags work the way they do. Air bags are designed to inflate in frontal crashes that are severe enough to cause injuries to an occupant. They are triggered by sensors in the front of a vehicle, designed to tell the difference between minor impacts and those that have the potential to result in significant injury. They are not designed to inflate at low speeds or in fender-benders. A typical crash speed resulting in inflation is 12 mph into an immovable barrier, or like hitting a parked car at about 25 mph. In a frontal crash, the occupant moves forward toward the windshield, dashboard, or steering wheel, prior to air bag deployment. The air bag inflator must produce enough energy to inflate the air bag fully in about 25 milliseconds to "cushion" the occupant before the occupant strikes the vehicle interior.

Background: Occupant Crash Protection Standard

Under Chapter 301 of Title 49, U. S. Code ("Motor Vehicle Safety "), the Secretary of Transportation is authorized to set Federal motor vehicle safety standards for the manufacture of all new motor vehicles and motor vehicle equipment. Standard No. 208, "Occupant Crash Protection," one of the original Federal motor vehicle safety standards issued under this statute, requires motor vehicle manufacturers to install safety belts in most vehicle types to protect occupants during a crash.

Prior to 1991, NHTSA gave manufacturers flexibility under Standard No. 208 to use any type of automatic protection system (belts or air bags) as long as the system passed the required criteria in a 30-mph crash test. However, Congress included provisions, authored by this Committee, in the Intermodal Surface Transportation and Efficiency Act of 1991 (ISTEA), signed into law on December 18, 1991, requiring all cars and light trucks and vans to have only air bags and manual lap/shoulder belts to protect front-seat outboard occupants.

Under ISTEA's phase-in schedule, 95 percent of a manufacturer's 1997 model year cars and all of the 1998 model year cars must offer air bags and manual lap/shoulder belts. Similarly, 80 percent of a manufacturer's 1998 model year light trucks and vans and all of the 1999 model year light trucks and vans must offer air bags and manual lap/shoulder belts.

As of July 1, 1995, about 35 million passenger cars and light trucks on our roads are equipped with driver-side air bags. About 12 million of these vehicles also have air bags to protect front-seat passengers. A decade ago, only a very few luxury cars were equipped with air bags. Today, nearly every 1996 model year passenger car will be equipped with both driver- and passenger-side air bags as standard equipment. Manufacturers are installing them in response to consumer demand, in advance of the statutory requirement.

Benefits

Air bags have been and continue to be an effective, life-saving technology. Numerous evaluations of their effectiveness have been conducted. All conclude that air bags are approximately 30 percent effective in reducing fatalities in pure frontal crashes (12:00 o'clock point of impact), and about 18 percent effective in all frontal crashes (10:00 o'clock to 2:00 o'clock point of impact). Based on this effectiveness, NHTSA estimates that air bags saved about 1,500 lives between 1987 and 1995, with an estimated 570 lives saved in 1995 alone.

With regard to overall injury reduction, the combination of an air bag plus a lap-shoulder belt provides the same injury-reducing protection as belts alone, in all types of crashes. Both systems reduce the risk of injury by some 50 percent. Further analyses of these data show that air bags reduce the likelihood of injury to an occupant's head, neck, face, chest, and abdomen, compared to the lap/shoulder belt. The air bag and lap/shoulder belt combination reduce this injury risk by 59 percent compared to 47 percent for manual lap/shoulder belt. Injuries to these parts of the body

are much more likely to be life threatening. These analyses also show that air bags can be associated with increased risk of arm injury. NHTSA is conducting additional analysis and research to further address these issues.

As the air bag fleet increases, the lives saved by this technology also will grow. Almost all of the experience in evaluating air bag effectiveness has been based on driver-side air bags, the majority of the current air bag fleet. The passenger-side air bag fleet has been, and continues to be, too small to conduct statistically significant evaluations of their life-saving benefits. As the dual air bag fleet continues to grow, such studies will become possible. Currently, only anecdotal information, located and developed by NHTSA's Special Crash Investigation program, is available on passenger-side air bags.

NHTSA has long emphasized that the presence of an air bag does not mean it is less important for occupants to use their safety belts. Air bags are supplemental restraints. They only work in frontal crashes. The safety belt, which provides protection in all kinds of crashes, is the primary means of occupant restraint. In 1995, our preliminary estimate is that safety belts saved almost 9,500 lives and prevented several hundred thousand moderate to critical injuries. In short, the combination of wearing safety belts and having air bags installed at front seating positions provides vehicle occupants with the maximum protection in all types of crashes.

Concerns

Although the safety of air bags is well documented, there are certain situations in which air bags can have adverse side effects. As more vehicles are equipped with them, these side effects have become better known to researchers.

The table below shows the types of situations in which the agency has some information suggesting there may be a risk of serious injury to vehicle occupants from the air bag.

Group Affected	Seating Position of Primary Risk	Probable Cause of Problem
Small Statured and/or Older People (Usually Unrestrained)	Driver Position	Proximity to Air Bag at Time of Deployment.
Infants in Rear-Facing Child Restraints	Passenger Position	Proximity to Air Bag at Time of Deployment.
Children Unrestrained in Front Seat	Passenger Position	Proximity to Air Bag at Time of Deployment.
Out-of-Position Occupants	Driver and Passenger Position	Proximity to Air Bag at Time of Deployment.
Persons with Disabilities	Driver Position	Proximity to Air Bag at Time of Deployment; Adaptive Equipment between Air Bag and Driver; Safety Features in Vehicle Must be Modified to Accommodate Adaptive Equipment.
Persons Experiencing Extremity Injuries	Driver and Passenger Position	Unknown; Under Study.

It appears from this table that the primary task is to reduce the risk to occupants who are very near the air bag at the time of deployment. As of October 1, 1995, NHTSA had identified 17 driver deaths associated with driver-side air bag deployment. Most of these were determined to be unrestrained or out-of-position at the time of the crash. The others were small-statured elderly drivers.

As of February 1996, NHTSA's Special Crash Investigation program has identified 15 crashes where the deployment of the passenger-side air bag resulted in fatal injuries to a child. Four of these deaths were to infants in rear-facing child seats. The 11 other children were determined to be unrestrained or improperly restrained (i.e., wearing only the lap belt with the shoulder belt behind them) at the time of the crash. All of these cases involved pre-impact braking. This combination of no, or improper, belt use and pre-impact braking resulted in the forward movement of the children such that they were put in close proximity to the instrument panel and the air bag system at the time of the crash and the deployment of the air bag. Because of this proximity, the children sustained fatal head or neck injuries from the deploying passenger-side air bag. Eleven of the investigations are completed. The remaining four should be completed this month.

NHTSA is extremely concerned about these deaths. If there is no change in behavior or in the technology of air bags, then we can expect that as air bags increase in number in America, injuries and fatalities such as those described above will in-

crease commensurately. Eliminating or reducing the risks resulting in these deaths is the agency's number one priority. NHTSA is devoting significant resources to respond expeditiously. My later testimony outlines the many agency activities we have underway to define the problem or set of problems, identify proper solutions, and take action to implement these solutions.

Parents and others who drive with children under the age of 12 need to be aware that children in this age group are very different physiologically than adults. This makes them much more vulnerable to injury in a crash. Once aware of this added risk, particularly in the case of air bags, adults need to ensure that these children will not ride without a seat belt or child safety seat.

Persons with disabilities may have problems with air bags in addition to those that result primarily from their proximity to the air bag at the time of deployment. While many drivers with disabilities may have a problem because of having to sit very near the steering wheel, they may also face unique problems due to the special adaptive equipment they need to drive. This adaptive equipment may reduce the effectiveness of air bags by interfering with their deployment. In September 1994, the agency issued a consumer advisory cautioning drivers with disabilities not to use steering control devices mounted on a bar installed across the steering wheel hub (a "spanner bar").

NHTSA currently lacks sufficient data to decide if air bags will pose unique problems for drivers with disabilities because of the interaction with the special adaptive equipment they need to drive. However, the agency will conduct tests during fiscal year 1996 to examine this subject in detail.

Prospective Remedies

NHTSA is taking steps to address the adverse effects of air bags. A variety of possible remedies exist. In the short term, behavioral changes are the most realistic and would bring the most immediate benefit. If every child were properly restrained, the risks would be minimized. In the intermediate term, major gains will be made through adapting advanced technologies as well as through possible regulatory actions. In the long term, we believe technology has the potential to eliminate most adverse effects.

The chief difficulties in finding technological remedies are associated with the complexity of this technology and the lead time that would be required to incorporate changes into new vehicles. Determining optimum air bag performance requires choices among numerous variables. For example, different air bag designs feature different deployment thresholds, mounting positions, inflator speeds and air bag sizes. These design approaches are chosen because of differing vehicle designs and the manufacturer's design philosophy. Separately, it is important to recognize that there is not one optimal solution to the very difficult design challenge of providing the best protection available to the widest range of occupants. In fact, there are significant trade-offs in overall safety performance that are affected by these choices.

Some serious injuries and fatalities have occurred in low-speed crashes when an occupant is in close proximity to the air bag, either because a rapidly expanding air bag "punches" into the occupant and causes crushing type injuries, or the air bag "membrane" effect, causes hyperextension of the neck, and/or stretching the head from the body of the occupant. Suggestions have been made to lower the speed and energy with which the air bag deploys; however, this could lead to air bags that do not provide adequate protection to normally seated occupants or in high speed crashes because of a reduction in their cushioning capacity. Moreover, no one today knows how many air bag injuries would be prevented by reducing their aggressivity, or how many lives would be lost due to less protection at higher speed or larger occupants.

Increasing the crash severity at which air bags deploy also has been suggested. This would lessen the number of deployments at low speed where the probability of injury for occupants (even unrestrained occupants) is small. On the other hand, with one type of crash severity sensor used by some manufacturers, raising the deployment threshold provides less time for the air bag to deploy, possibly resulting in more aggressive air bag deployments and more of the "punch out" or "membrane" injuries discussed above.

Proposals suggesting modification of Standard 208 require a great deal of data, analysis and study to assure that we are fully aware of any trade-offs in overall safety performance of air bags. It is not a simple matter to identify and measure the effects of these changes. Though the theories underlying these proposals have been discussed, none have been fully reviewed and the impact of these possible changes have not been quantified. The questions posed in NHTSA's November 1995 request for comment, discussed in detail later, reflect many of these complexities.

Prospective Remedies: Behavioral Efforts

Since discovery of the risk to infants in rear-facing child seats, NHTSA has been aggressive in warning parents and other care givers. NHTSA's position is that rear-facing child seats should be used *only* in the rear seat of a vehicle with a passenger-side air bag. As mentioned earlier, as proper restraint use increases, the risk of adverse air bag effects decreases.

Because of our growing concern of the risk to improperly restrained children in air bag-equipped positions, on October 27, 1995, NHTSA issued a strong warning in a press release, "SAFETY AGENCY ISSUES WARNING ON AIR BAG DANGER TO CHILDREN," which "... warned that children who are not protected by a seat belt could be seriously injured or killed by an air bag, and in the strongest possible terms urged parents to insist that their children ride belted in the back seat whenever possible."[1] This notice repeated prior agency warnings of the dangers of placing a rear-facing seat in front of an air bag, and broadened the previous warnings to include older children and even adults who may ride unrestrained. To ensure that infants and children ride safely, with or without a passenger-side air bag, this warning and advisory urges care givers to follow three rules:

In 1991, NHTSA had issued a Consumer Advisory warning owners of rear-facing infant restraints not to use such a restraint in the front seat of a vehicle equipped with a passenger-side air bag.

- Make sure all infants and children are properly restrained in child safety seats or lap and shoulder belts for every trip.
- The back seat is the safest place for children of any age.
- Infants riding in rear-facing child safety seats should never be placed in the front seat of a vehicle with a passenger-side air bag.

The importance of getting this message out is shown by the fact that 40 percent of our children still ride without the critical protection of a seat belt or child safety seat. Last year, about 72 percent of all the children who were killed in the front seat a motor vehicle were riding unrestrained.

That announcement received extensive media coverage, as did our numerous—and continuing—efforts to inform the public about this. In October 1992, NHTSA published a final report describing child restraint/passenger-side air bag interactions. The report concluded that rear-facing infant restraints should never be placed in the front seat of a vehicle with a passenger-side air bag.

Since NHTSA's October 1995 warning, we have enhanced our efforts to: (1) stimulate a public dialogue on air bag performance; and (2) intensify our campaign to properly restrain children. A large part of the agency's plan is to increase information to the affected public through our many traffic safety partners throughout the country. With this support, we will be able to extend the reach of our safety messages to a wider population.

We believe national safety belt use rates can be increased significantly beyond the current national average of 67 percent. We know, for example, from our own research and demonstration efforts and the efforts of the insurance and automobile industries, that three ingredients are essential to increasing safety belt use: (1) strengthening current state safety belt use laws to allow for primary enforcement; (2) implementing periodic, highly visible enforcement programs in the states so that the public will know these laws are important and are being enforced; and (3) conducting public information and education programs to reinforce these efforts and alert the public to the dangers of riding unrestrained or improperly restrained.

To increase the number of properly restrained children, the agency has intensified its campaign to make the public more aware of the special precautions needed when transporting infants (under one year old) in vehicles with passenger air bags, and also to ensure that other young children (over one year old) are properly restrained at all times, by either a child safety seat or by the vehicle's safety belts, as appropriate.

On January 16-17, 1996, NHTSA co-sponsored, in partnership with the National Safety Council, a national conference, "Safety Belts, Air Bags and Passenger Safety: A Call to Action," to develop an action plan to address the problem of injuries related to air bag deployments. During the conference, our public and private partners agreed that NHTSA's efforts in this area should focus on increasing proper safety belt and child safety seat use, especially for young children.

The agency is pursuing several activities consistent with these recommendations. In addition to the extensive media coverage generated by the press releases and

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[1] In May 1995, NHTSA published a final rule amending the Federal motor vehicle safety standard for occupant crash protection to allow manufacturers the option of installing a manual cut-off switch that motorists could use to deactivate the passenger-side air bag in vehicles such as pickup trucks and sports cars, in which infant restraints can only fit in the front seat.

Federal Register notices mentioned earlier, we have developed various media materials to alert the public about the problem of injuries related to air bag deployments and the proper precautions to take to avoid these problems. Some of these materials include a camera-ready folio for use by interested parties at the state and local level, a video news release (VNR) for broadcast and cable transmission, and articles for publication in newsletters and magazines.

The most important of our many public information and educational activities is our effort to develop a national movement of public and private sector organizations to aid in the prevention of these injuries. The national conference we co-sponsored this January marked the beginning of that effort. We are currently working with the automobile and insurance industries, as well as many health, medical, and safety groups, to develop a broad-based public/private coalition to implement the recommendations adopted at that conference.

The objectives of this coalition will be to implement the three-point plan of legislation, enforcement, and public information that was endorsed by the participants of the January conference. We are certain that by combining and focusing public and private resources on the elements of this plan we can significantly increase the number of children (and adults) who are properly protected by lap and shoulder belts. We can also increase the level of awareness among parents and other care givers regarding the dangers of placing a rear-facing child seat in front of an air bag.

Prospective Remedies: Technological

Test Program for Out-of-Position Occupants. The agency has initiated a research testing and analysis program to address the problem of all out-of-position occupants. The program is being conducted at the Vehicle Research and Test Center, the agency's in-house laboratory in Ohio. The program's objectives are to:

- Assess the performance of air bag systems in current production vehicles in particular crash conditions, including out-of-position children.
- Assess the level of improvement possible in out-of-position performance with change to existing air bag components, as well as newly developed pre-production systems.
- Provide visibility for air bag-related technology, thus promoting the rapid adoption of newer technologies that will help solve the out-of-position occupant injury problem.

The immediate focus of the program is on the passenger-side out-of-position problem as related to children. Several vehicle models have been selected based upon field accident investigations and air bag design characteristics. Both domestic and foreign vehicles are included in the selection. The test conditions include four different child positions recommended by the International Standards Organization, and represent worst case occurrences. These tests will provide "baseline" performance of air bag systems when a child is an out-of-position occupant.

NHTSA is inviting vehicle manufacturers and air bag and component suppliers to provide state-of-the-art air bag systems. Systems that show significant improvements over baseline performance for out-of-position children will also be tested with adult-sized dummies in full-scale crash conditions required in Federal standards. Some of the newly developed systems may prove to be safer to out-of-position children, but may not pass the current safety standards required for adult occupants. We hope to complete this phase of the program by this summer.

The test program will also address other aspects of air bag safety following the out-of-position child study. These include out-of-position driver tests, vehicle crash sensor testing, and testing of advanced air bag systems. The out-of-position driver testing will focus on small-sized female occupants who are sometimes injured due to the close proximity to the steering-wheel air bag system. Testing will continue into fiscal year 1997.

While NHTSA anticipates that "smart" bag systems will substantially minimize adverse side effects of air bags, this still leaves open the question of what can be done in addition to public education for the near future. NHTSA believes that manufacturers will continue to make adjustments to existing air bag systems to further improve their performance. The agency also may make adjustments to its regulations, if they are appropriate to enable manufacturers to minimize adverse effects and result in overall improvements in safety. And, a possible legal issue exists as to the extent to which NHTSA may amend Standard 208 in light of the reference to that standard in ISTEA.

1995 Request for Comments. To act expeditiously to ensure that adverse side effects of air bags are minimized or eliminated, NHTSA published a request for comments on November 9, 1995, seeking ways air bags could be changed to minimize

adverse side effects and summarizing what the agency knows about the adverse side effects of current air bags.

In the November notice, NHTSA also asked vehicle manufacturers, air bag suppliers, insurers, members of the medical community, and any other interested members of the public to share information about air bag designs and experience. The closing date for comments on this notice was December 26, 1995. Most of the 1,400 pages contained in the 54 comments received by the agency are highly technical in nature, and we are currently engaged in an intensive evaluation of the issues discussed in these comments.

Because decisions on possible rulemaking on these issues have not yet been reached, we do not have any recommendations to announce at this time for modifying the present regulations. The agency hopes that this request for comments will help the agency obtain the information needed to make reasoned decisions about whether some regulatory changes are needed for the interim period, whether some simple technological fixes are available to minimize side effects until smart bags become a reality, or whether other activities, such as consumer information, offer the best chance of effectively minimizing these side effects.

Information Requested. To aid the agency in obtaining useful comments, NHTSA's November request for comments asked the public to respond to 34 specific questions and requests for data. Although NHTSA relies primarily on data from its Fatal Accident Reporting System (FARS) and its National Accident Sampling System (NASS), including the Special Crash Investigation Program, to monitor air bag performance in crashes, the agency believes that the public, particularly insurers, vehicle manufacturers, and the medical community may have information that would supplement the NHTSA data regarding air bag performance in crashes. We asked for data on the benefits/injuries associated with air bags to supplement the data NHTSA already collects. These data will allow the agency to do further analyses and evaluations to better understand how air bags are performing on the road.

NHTSA also asked for air bag design data and the criteria specified for deployment of current air bag designs. The request for comments specifically asked for information about current deployment thresholds and why those levels were chosen, as well as the inflator characteristics of current air bags and why those characteristics were chosen. The agency also asked for detailed information about air bag size, mass and materials, folding patterns, venting, and whether the bags are mounted on the top or front of the dash. This information is being analyzed to learn if there is sufficient flexibility within the standard to allow manufacturers to minimize any adverse effects of air bags without any regulatory changes.

The agency asked for information on possible solutions to the adverse effects. These possible solutions included pedal adjusters that would allow drivers to sit further back, recessed inflators, depowered inflators, and manual air bag cut-off switches. NHTSA is analyzing the information it received in these areas to assess the effectiveness of each of these possible courses of action to minimize adverse effects of air bags.

The notice concluded with a series of questions seeking special information on whether persons with disabilities need any special actions to reduce the risk of adverse effects from air bags. NHTSA will use this information to ensure that it has carefully considered the needs of these persons in any action to minimize side effects.

Our specific questions covered the following subjects: (1) Field Experience With Air Bags; (2) Crash Sensing; (3) Air Bag Inflators; (4) Air Bag Design; (5) Proximity Considerations; (6) Near Term Considerations; (7) Future Plans; (8) Obstacles to Near and Long Term Plans; and (9) Air Bag Issues Related to Persons With Disabilities.

On Field Experience With Air Bags, we asked commentors to provide any available information on air bag performance in cases including deployment in which the air bag may have contributed to serious injuries or fatalities for occupants. If such cases are identified, we asked for any details about the position in which the occupant was seated (driver or passenger position), the injured person's gender, age, height, and weight, whether the occupant was belted, unbelted, or in a child restraint, and the source for this information (e.g., police report, insurance claim, hospital report, etc.). We also asked for available information concerning the reduction or increase in different types of injuries and injury severities that may be associated with the introduction of air bags. The medical community, in particular, was requested to respond to this question.

On Crash Sensing, we noted that NHTSA's data indicate there are situations in which air bags appear to have contributed to serious or fatal injuries that have occurred at crash severities below 15 mph, some even below 10 mph, with minimal damage to the vehicle. We asked commentors to provide information that would

help NHTSA assess the range of deployment thresholds currently chosen by vehicle manufacturers for their different vehicles, why those differences exist, and the manufacturers' efforts to adjust and redefine the algorithms used to determine whether the air bag should deploy. For example, we specifically asked what algorithms and calibrations do manufacturers use to determine when the air bag should deploy in each of their vehicles? Also, what are the reasons why that threshold for air bag deployment was chosen (e.g., corresponds to the speed at which an unbelted occupant would experience facial fractures from steering wheel, speed at which unbelted occupant would be likely to experience serious chest injuries, etc.)?

On Air Bag Inflators, we noted that Ford had indicated in a request to the agency, mentioned earlier, that it could reduce the air bag inflator onset rate simply by decreasing the amount of propellant contained in the inflator. Ford had said that such a change could be made quickly and would, in Ford's opinion, reduce the incidence of air bag-induced injuries, particularly to upper extremities, and allow more optimal tuning of current safety belt systems. In view of Ford's request, we asked commentors to provide as detailed information as possible about current air bag inflators, including inflator tank pressure curves, the effect of reduced propellant on those pressure curves and the overall performance of the inflator, and inflators that use dual or multiple staged inflation. We stressed that the agency is particularly interested in learning why manufacturers have chosen the particular characteristics for the inflators used in their vehicles (e.g., cost, simplicity, etc.) and the lead time that would be needed to change inflator characteristics in production vehicles.

On Air Bag Design, NHTSA knows of many variables that may affect the performance of air bag systems in the field. In view of these variables, we asked commentors if data exist which indicate whether any of these variables significantly affect the performance of air bag systems. The variables NHTSA has identified thus far include:

Air Bag Volume
Air Bag Fold Patterns
Air Bag Tethering
Air Bag Venting
Air Bag Mass/Material
Shape and Size of Air Bag Module Opening
Module Location and Deployment Path

To help answer questions about these variables, one of the specific questions we asked was the estimated lead time needed to change each of these variables in production vehicles, and what are the reasons for why such lead time is needed.

On Proximity Considerations, the agency noted that most of the fatalities involving air bags have occurred to children and small-statured adults who were unbelted or otherwise improperly restrained, possibly out of position, and very close to the air bag at deployment. To assist the agency in identifying possible approaches to mitigate the problem in these circumstances, we asked commentors to provide any data or information that may be available on subjects such as:

Is there a quantified minimum safe distance from the inflator nozzle/air bag at the time of deployment for air bags generally or for any particular air bag designs? If so, please provide that information and the data in support of that distance.

For the following questions, we stressed that the agency is especially interested in all the data and information that support the response given. In addition, the agency would like the public to identify the trade-offs that would be involved in taking any of these actions:

Do "top mounted" air bags substantially reduce the adverse side effects at the passenger position?

Can the adverse side effects be substantially reduced by recessing the inflator/air bag either in the steering wheel assembly or in the dash?

Would displacement of the inflator away from the occupant at deployment substantially reduce the adverse side effects?

Would pedal adjusters (which move the pedals closer to the driver and allow the driver's arms instead of leg length to determine how close the driver must sit) reduce adverse side effects of air bags by allowing drivers to sit further back?

Would telescoping and/or tilt steering wheel assemblies substantially reduce the adverse side effects of air bags?

Can advanced sensors, which would not deploy when an occupant was too close to an air bag, substantially reduce the adverse side effects of air bags?

Would safety belt pre-tensioners reduce the risk of air bag deployment injuries?

What laboratory test procedures and devices do manufacturers use and find appropriate to assess inflation hazards to occupants in close proximity to the driver or passenger air bag?

On Near Term Considerations, six months to one year, we asked if there are changes that could significantly reduce the probabilities of the serious injuries and fatalities attributed to air bag deployment. The agency is aware that some possible near term changes to air bags could involve safety tradeoffs—that is, reducing certain types of injuries while allowing increases in others, offering higher protection at lower speeds at the expense of less protection at higher speed crashes, or protecting certain types of occupants (e.g., belted or those of small stature) at the expense of others (e.g., unbelted or large occupants). We stressed that we would like to obtain information on possible near term changes and any safety tradeoffs associated with such changes. We noted that we are particularly interested in the effects of any potential changes on particular groups, such as young adults and children, and occupants of the growing light truck and van

market, where belt use has traditionally been lower. Examples of the questions on this subject include:

What would be the safety consequences of permitting manual air bag cut-off switches? Are there policy or other considerations that warrant treating the driver's and passenger's positions differently? How difficult would it be to retrofit such devices for vehicles on the road?

It seems that a change in deployment threshold could be made relatively quickly simply by modifying the calibration of the sensors or the algorithm used for deployment. What is the estimated lead time needed to change the deployment threshold used in current air bag designs, and why is that amount of lead time needed to make such a change?

What would be the safety consequences of a reduction or modification of the inflation rate?

How quickly can the manufacturers develop module locations that are recessed in the steering wheel or the instrument panel?

On Future Plans, we noted that the agency is aware that much effort is underway to develop various levels of "smart" air bag systems, and that these systems may range from dual threshold sensors that deploy the bag at different crash severities by recognizing whether the occupant is restrained or unrestrained (such systems are already in some luxury vehicles) to systems that include items such as:

Variable inflation rates
Occupant seat sensors
Proximity detection/sensing
Dual or multi-stage inflators/sensors
Dual or variable venting, etc.

For each of the above areas, we asked commentors for detailed information concerning the technologies and strategies being considered, as well as any other advanced air bag concepts, and the potential and expected dates of implementation.

On Obstacles to Near and Long Term Plans, we requested information and any explanation of obstacles that may hinder advancements in reaching near or long term solutions to problems regarding air bag performance in crashes. These could include or require changes in present regulations or the development of new regulations. We asked for recommendations for any agency actions that could be beneficial, the rationale for that action, and its safety consequences (quantified, if possible).

Also, under this subject, Ford requested that NHTSA amend its crash testing procedures in Standard No. 208. The standard currently requires test dummies to be protected in a 30-mph crash both when wearing safety belts and when not wearing the belts (i.e., protected by the air bag alone). Ford asked that the test speed for the unbelted dummies be lowered to 25 mph. According to Ford, this change would allow manufacturers to better "tune" the interaction between the air bag and the safety belt so as to optimize the protection afforded to occupants who use their belts. Ford stated that the current testing procedure forces manufacturers to base occupant protection designs solely on the air bag, rather than the interaction between the air bag and the belt. Ford believes that such a change can reduce air bag-induced injuries.

In view of Ford's request, we asked:

If NHTSA were to make a short-term change in Standard 208 to facilitate quick reductions in air bag inflation speeds (i.e., a change that would apply until manufacturers can implement smart air bags or other design changes to address low speed air bag injuries), how would manufacturers respond? What would be the specific safety consequences of such a change, including possible adverse consequences for unbelted occupants and for occupants in much higher speed crashes?

A reduction in Standard 208's unbelted test speed might not be the only way to facilitate quick reductions in air bag inflation speeds. For example, NHTSA could possibly retain the 30 mph unbelted test but temporarily increase the chest loading maximum of 60 g's for that test. Standard 208 currently specifies the same chest loading maximum for both the belted and unbelted tests. The agency notes that a preliminary review of recent biomechanical data generated for NHTSA suggests that the human tolerance to acceleration for serious chest injury may be higher for air bags than for belts, because the air bag delivers a more broadly distributed, uniform loading to the chest than does a safety belt. Would manufacturers respond to this type of change differently than for the change suggested by Ford? What would be the specific safety consequences of such a change, including possible adverse consequences?

Finally, on Air Bag Issues Related to Persons with Disabilities, we asked a broad range of questions, including whether is it very common that children with disabilities (whether small enough to use a child seat or not) must, for health reasons, sit in the front seat to be near the driver, when the driver is the only adult in the vehicle. Of these, how many cannot use conventional seat belts, or child seats, due to their disabilities?

Currently, we are completing our analysis of data provided from our request for comments, our subsequent meetings with vehicle manufacturers, and from test programs underway in the agency and elsewhere.

Prospective Remedies: Future Technologies - "Smart" Air Bags

Like most newly introduced technologies, air bags have the potential for improvement. Design changes can offer better protection to more occupants in more kinds of crashes at different levels of severity. This next generation of highly advanced air bags, called "smart bags," will employ sensors that can adjust inflations, depending on whether occupants are belted, on their size and weight and position in their seats, including the distance from the steering wheel or dashboard, and inflate at different speeds according to the severity of the crash. Through technologies such as infrared and acoustic sensors, the position of the occupant can be determined and monitored as pre-impact braking and a crash occurs. With weight sensors in the seat and safety belt usage sensors, the size of the occupant and any use of safety belts can be determined. Sensors can determine if an infant or child safety seat is being used and in what direction it is facing.

More sophisticated crash sensors, including pre-crash sensing radar, can be used to inform the air bag system of appropriate deployment strategy. Variable rate inflators and variable bag shapes and sizes can be employed to better address crash and occupant variables. These new technologies are in various stages of development and maturity. While any one of these technologies could enhance air bag effectiveness, a comprehensive system involving many of these new technologies is needed for a major improvement in air bag effectiveness. Under the best of circumstances, most of these sophisticated technologies cannot be fully researched, developed, debugged, designed, tested, tooled, manufactured, and installed into vehicles for several years.

In closing, I would like to repeat a caution that deserves repeating: No safety device is a panacea; ultimately, drivers and passengers must take responsibility for their own safety. Parents and other drivers should remember and follow three basic rules to ensure that children are not exposed to air bag-related injuries:

(1) Make sure all occupants are properly buckled up, regardless of where they sit.

(2) The rear seat is the safest place for children of any age to ride.

(3) Never put a rear-facing child seat in the front seat of a car with air bags.

This concludes my remarks. My colleagues and I would be pleased to try to answer any questions you may have.

The CHAIRMAN. Thank you, Dr. Martinez.

You indicated that reducing the risk of injury and death to children from the deployment of passenger-side air bags is the agency's No. 1 priority. I understand the most important precaution is to make sure infants and children are appropriately restrained by a safety belt or a properly positioned child safety seat. What actions are you planning to undertake to address this serious concern?

Dr. MARTINEZ. You are absolutely right. One of our big concerns, and this is our No. 1 priority, is that many children riding in the right front seat are out of position. That is, they are unrestrained. When the crash begins, they are moved forward, through braking of the vehicle. When we look at that, we see not only unrestrained children, but also improperly restrained children.

So what we have done is we have been aggressive this last year to expand our constituency groups, to go beyond just the safety organizations to go also to medical organizations, a variety of organizations, and try to get the message out.

I would like to turn it over to Associate Administrator Jim Hedlund to give you some of the details on what we have done to date so far.

Mr. HEDLUND. We sent out information to a wide variety of organizations and partners, including businesses, insurance organizations, automobile dealers, health and safety organizations, and so forth. We publicized the issues very clearly in this air bag alert, which makes the three points that we think are clearly important: Always make sure that your child is properly buckled up, never put a rear-facing child seat in the front seating position by an air bag, and the safest place for your child is in the rear seat.

We have received enormous cooperation to help spread this message in a variety of ways. I can provide you with a lot of detail. We conducted a conference for over a hundred organizations in January, which, again, got that information out, set up a coalition, and put forth a call to action. In this folder—which I would be glad to give to the committee—are a number of examples of ways in which this publicity has been gotten out to a variety of organizations.

Dr. MARTINEZ. I would like to commend Mr. Hedlund for his efforts, but let me tell you we have done some extraordinary things also. We worked with the CDC to send out one of their Morbidity/Mortality Weekly Reports, specifically focused on this. Though they were in furlough, they felt this was such an emergency that they sent this out to the public health world. The FDA has sent out over 1.2 million alerts for us, specifically directed to physicians.

For parents of young children, for example, with rear-facing seats, that is a very early opportunity for contact in the hospitals, and through pediatricians. So we really are trying to get the message out, not only through the broad media, but through selective groups that we think can help us resolve this issue.

The CHAIRMAN. Now, what kind of research is NHTSA conducting to improve air bag safety?

Dr. MARTINEZ. We are working right now, through the request for comments, to ask manufacturers and suppliers to bring us a lot of their best practices, share their information with us. And, based upon a lot of that information and the previous work we have done, we are embarking upon a R&D effort that I would like Mr. Boehly to mention.

Mr. BOEHLY. Thank you, Ric.

Yes, Mr. Chairman, there are a number of areas on the research side. First, on the accident data itself, clearly, to get more information on these crashes, the reasons for these kinds of injuries that we are seeing, to really understand the relationship between crash

severity and occupant injury. So there is a very large effort looking at accident data.

On the vehicle side, we are working with manufacturers to look at the types of air bag systems that are out there today, how these air bag systems can reduce the aggressivity that we are seeing both on the driver and passenger side. As Dr. Martinez mentioned, the principal problem we have with air bags is people are up against the steering wheel or children are up against the dashboard. The question is: What can you do to air bag covers, to air bag designs themselves, the fabric, the inflation characteristics, the inflators themselves, to try to mitigate these kinds of consequences?

So we are working with manufacturers to have a coordinated and cooperative test program, to understand the baseline performance of these systems—that is, what is out there today, what can we do in the near term, and also, quite frankly, in the future, what we can do to bring out smart air bag technology. This is some time away, but we see that as the real solution to this problem.

The CHAIRMAN. When one examines overall injury reduction produced by air bags, your data suggests using air bags in combination with safety belts provides roughly the same overall injury reduction as using safety belts alone.

You also indicated air bags tend to cause arm injuries. When these injuries are excluded and one focuses on injuries that are more likely to be life threatening, air bags and safety belts then have an advantage over safety belts alone.

Does this data, in your opinion, accurately reflect the injury-reduction benefits of using air bags in conjunction with safety belts, and what type of arm injuries are caused by air bags?

Dr. MARTINEZ. I will answer that briefly and then ask Mr. Boehly, who is overseeing our R&D on that and our data, to further respond. That is exactly right. When we talked about tradeoffs, those are some of the questions I mentioned earlier. Head injury continues to be the leading cause of death in motor vehicle crashes. The leading cause of all head injury, serious, long-term head injury, is motor vehicles, in this country.

So if you look at all injuries, from kind of moderate to fatal, we see very little difference between the air bag-lap/shoulder belt, and the lap/shoulder belt alone.

However, if you look at the ones that increase the threat to life—for example, you do not die from an arm injury—then what you see is a decrease in those—most notably the head, the chest and the spine—due to the air bag. However, there is an increase in the number of arm injuries at this point in time, and also large brush burns.

So we feel that they address the problem of the serious and fatal injury. The air bags are very effective in frontal crashes.

I am trying to remember the second part of the question.

The CHAIRMAN. Yes, what types of arm injuries are caused by air bags?

Dr. MARTINEZ. They are very interesting injuries. I will let Mr. Boehly mention that, but they are very interesting injuries. There are several mechanisms. One occurs as the arm is knocked up, and then there is an impact inside of the car. But also, in the deployment of the air bag itself, there may be direct impact to the arm

which, in some cases, can cause fractures of both bones, probably the most severe injury we have seen.

Mr. BOEHLY. Mr. Chairman, back to your first point about the effectiveness of air bags. You are absolutely correct that when you look at the overall effectiveness of air bags for all injuries, they are about the same—air bags-lap/shoulder belts, lap/shoulder belts by themselves.

But you made a very important point that when you look at the most important injuries, that is, those that are occurring to the head, to the neck, these injuries have been reduced considerably by the combination of air bag and lap/shoulder belts.

Whereas the lap/shoulder belt system itself is 47 percent effective in reducing those types of injuries, the air bag-lap/shoulder belt combination is fully 12 percentage points higher, that is, 59 percent effective in reducing those most life-threatening types of injuries.

Regarding the issue of arm injuries, as Dr. Martinez pointed out, we are seeing abrasions, we are seeing some arm fractures. To address that problem, we have an ongoing research program which is identifying those types of injury mechanisms, relating those back to the kinds of things that you see in an air bag design—that is, again, the mass of the cover, the characteristics of the air bag, the fabric, the inflation characteristics—to try to address those kinds of air bag characteristics that are associated with these arm fractures, and what can we do to share that information to further improve the performance of these air bags in the real world.

I must say the manufacturers are very much involved in that as well. So there is an active, ongoing research program to address that issue of arm injuries, the types of systems that are out there that are causing those kinds of injuries, and what can be done through product improvements to address them.

The CHAIRMAN. From an overall point of view, we have had hearings in this committee on rail safety and air safety. The numbers of people who die or are injured in car accidents are much higher. Of course, many more people travel by automobile. Do we have a higher tolerance for accidents when it comes to automobiles? I know the speed limits have just been raised in a number of States.

Would you make some comparisons on our reactions to air safety, rail safety and car safety?

Dr. MARTINEZ. I am always amazed that we tend to not have the focus that we should on motor vehicle crashes in this country. This is what is killing our children. This is what is killing our next generation. Yet, we tend to be somewhat numb to this.

I talk to people who are worried, for example, about violence or AIDS, which I think are very important things to be worried about. And when I ask why they say, "Well, it is in the paper all the time; look at what is happening." But you can pick up the paper any day and see these crashes occurring.

You know, we have 6.5 million crashes a year. We have hundreds of thousands of long-term disabilities. We have 41,700 deaths. That is 113 people a day. That is equal to——

The CHAIRMAN. How many deaths a year from automobile crashes?

Dr. MARTINEZ. Right now, 41,700.

The CHAIRMAN. 41,700.

Dr. MARTINEZ. That is equal to three 747's a week crashing. If that happened in this country, we would be so focused to solve this problem. Yet, my feeling is it is somewhat of a neglected epidemic.

Now, what is interesting is that people are beginning to understand, through the information highway, that motor vehicle crashes affect us all. We did a recent study, where we just took data from States, and linked the crash data through the health care data, and began to see that we are all paying for this. It affects us, not just from the fatalities, but from the number of injuries.

There was a study released in the *Journal of Trauma* this last month, where the Army looked at its head injuries. Over 50 percent of the cost of head injuries in the Army comes from motor vehicle crashes. So it is still a major concern that we need to be focused on. We are doing our best to kind of make sure that when people are worried about risk in this country they understand that their biggest risk to their children and young adults is from motor vehicle crashes. There are things that can be done about it.

The CHAIRMAN. What is your reaction to the increase in speed limits? Are air bags and the new technology making cars more safe so that we are in a better position or worse position?

Dr. MARTINEZ. Well, truly the cars have gotten safer over the years. Probably the biggest change has been the dramatic increase in seat belt use because of the leadership from various people who have pointed out the benefits of those devices. We have gone from about 16 percent usage 10 years ago to about 67–68 percent usage now. That makes for a dramatic increase in safety.

We are very concerned about the speed limits going up. When we go to different States and look, it is not clear that there is anyone who has data locally to show what the consequences are of speed-related crashes in contrast to just crashes overall. We are trying to work very hard with the National Governors Association and the National Conference of State Legislators to help them link their data bases—not new data bases, but just link what they have, so they can see what the consequences are of crashes and what the value, for example, of enforcement is.

I am always interested or concerned when I see States and counties wanting to cut police traffic services, but do not understand what it costs them not to have them. So I believe that this is an important issue that we need to bring to the local communities. We have tried to bring local data, because, at the Federal level when we say, "I am from the Federal Government, let me tell you what your problem is." that does not create buy-in and does not let people understand what happens to them.

We are working locally now to do local data collection and put together programs so that communities can see their costs associated with that and what their problem is. So we hope to see, by recruiting other organizations, such as the health care organizations and business organizations, to create greater focus on this and go after some of the hard-to-reach groups that are contributing to this problem.

The CHAIRMAN. Senator Bryan.

Senator BRYAN. Thank you very much, Mr. Chairman.

Dr. Martinez, I would like to compliment you and your staff in what I think is a very balanced and responsible approach to a con-

cern that has been raised, that is legitimate, and that we need to address. The groups that are at risk for potential injury are, as you have identified, small-statured and/or older people, infants in rear-facing child restraints, children unrestrained in front seats, and out-of-position occupants.

I want to ask you a couple of questions with respect to each category. The children unrestrained in the front seat, that seems to be self-explanatory. You are talking about youngsters who are in the front seat that do not have their seat belt on at all I take it?

Dr. MARTINEZ. Well, you know, I wish it was that simple, but that is the vast majority. The reason why I mentioned that is that we have done in-depth investigations of some of these cases. One of the areas that concerns us is, we have at least one case, and maybe two, where the child had the seat belt on, but improperly. I always worry that when you say "buckle up" that there are a lot of people in this country that do not understand how to wear a seat belt properly. So I think we need to do a better job of doing that.

But the bottom line is that, in both cases, whether they are unrestrained or improperly restrained, they have been placed in close proximity to that air bag at the moment of deployment.

Senator BRYAN. I take it that, at least in part, the solution there is better public education, in terms of the use of the seat belt and the risk that inhere in not having a seat belt on for youngsters as well adults?

Dr. MARTINEZ. Yes, sir.

Senator BRYAN. With respect to the rear-facing child restraint, you have talked about that. That, too, appears to be a public education issue; that the placement of the infant or child seat ought to be in the back seat, in terms of providing maximum safety. With respect to the placement of the infant seat in the front seat, I take it that should be in a rear-facing position?

Dr. MARTINEZ. I am sorry?

Senator BRYAN. On the front seat.

Dr. MARTINEZ. In the front seat.

Senator BRYAN. Yes.

Dr. MARTINEZ. A rear-facing child seat should not be used in the front seat with an air bag at all. The reason why is the design of the rear-facing seat moves the child's head in close proximity with the air bag at deployment. The rear seat of the car is always the safest part of the car. So we always think children should be there. A rear-facing child seat should always be in the back seat if there is a front air bag, passenger-side air bag.

Senator BRYAN. Do you have any data at this point with respect to the problem that you have called our attention to, with respect to infants, what impact public education programs are having on the proper use of seat belts with respect to youngsters and the proper placement of the child seat? Are we seeing improvement? Are we seeing an enhanced level of understanding on the part of parents and others who travel with children in their vehicles?

Dr. MARTINEZ. Can I show a graphic quickly?

Senator BRYAN. Yes.

Dr. MARTINEZ. Would you show the graphic on restraint use, please?

This is an interesting one I would like to share with the committee. I think the Insurance Institute for Highway Safety has a survey that looked at people's awareness of these issues and found some very interesting things. There was a lot of awareness, a lot of it, we think, to do with the focus we have been trying to put on it. But just to show you.

We have higher restraint use under 5 years old, but it is still fairly low. About 59 percent, under 5 years old, are restrained in this country. Then it drops off dramatically. The use for the 10- to 15-year-old age group drops off dramatically. Then it starts to go back up again, to our current levels, which are much lower than other countries like ours around the globe.

I think that we still have a lot of focus in this age group, both on the parents and on the teenagers and on children themselves. So it means our focus of just doing it through the media is one thing, but we need to do more about making people understand the risk involved in a crash itself, how a seat belt works properly and then how the air bag works, so people understand what they can do to protect them selves in a crash.

One of my concerns, for example, is people have said,

Well, what about injuries from seat belts? There are injuries from seat belts, but they are always associated with a crash.

Somehow, to not understand how violent a crash is, that it can wipe out four people in a tenth of a second, we have not gotten the message across.

The reason why I raise this issue is because we did a study when I was back at Stanford, looking at teenagers, and looking at their understanding of car crashes. We talked about car crashes in the science classes. We were surprised to find that they wore their seat belts when they were drivers but did not wear them when they were passengers. So somehow there was a fundamental gap in their understanding of that issue.

If we are not going to fill that gap, then I am not sure parents are going to be able to understand the risk to their children.

Senator BRYAN. Would you care to comment on what the role, in terms of public education, ought to be on behalf of the automobile industry and the insurance industry?

Dr. MARTINEZ. Well, we have put together this coalition to ask that exact question. What we would like to do is focus on the interaction with children and air bags so people understand the need to do three things: No. 1, put your child in the back seat if at all possible; No. 2, your child should be restrained properly and how to do that so you can do it properly; and, third, put the rear-facing seat always in the back seat.

We see a three-part component to all of this. No. 1 is the information campaign, to make people more aware, fill that knowledge deficit that we are talking about. No. 2 would be then to support the passage of primary seat belt laws. They are very effective in raising seat belt use. It also increases awareness of people. No. 3 is to increase the enforcement of those laws so that people know that the law has some bite to it and that that encourages them to buckle up even more. Then of course, in conjunction with that, a special focus on groups that affect children.

Senator BRYAN. What has been the industry response so far, both from the automobile industry and the insurance industry?

Dr. MARTINEZ. We have been very gratified that the automobile manufacturers have come together and offered money, put together a budget that they thought would be a reasonable one to effect all three of these components. It is fairly easy to deal with the manufacturers because they have two major groups that we can deal with, the domestic and the import associations.

On the insurance side, we tried for several weeks to bring the groups together. They are, as you know, regulated at the State level. Therefore, they have various representatives for the companies. That culminated with a meeting last week, when the Secretary of Transportation called them to bring people together to ask that question, to ask them to work on that. We have not heard back at this point. My last understanding was that they were going to meet with the manufacturers and see what their level of participation would be and how they might participate.

Senator BRYAN. So we might hear from them this morning, then, perhaps?

Dr. MARTINEZ. That might be, sir.

Senator BRYAN. And, finally, putting this into some context again, what percent of automobiles on the highway today have air bags?

Dr. MARTINEZ. The percentage of cars overall?

Senator BRYAN. Yes.

Mr. BOEHLY. Senator Bryan, in this year, we are looking at about 34 percent.

Senator BRYAN. About 34 percent. I take it when these regulations are fully implemented, over a period of years, that number will increase dramatically each year thereafter?

Mr. BOEHLY. Correct.

Senator BRYAN. I am told that, when fully implemented, that air bags can prevent 9,000 fatalities a year and reduce serious injury by tens of thousands more. Would those numbers be in the ball park, Mr. Boehly?

Mr. BOEHLY. Senator, those numbers are certainly our best estimates right now. As Dr. Martinez indicated in his opening statement, we are looking at a system that is about 30 percent effective in purely frontal collisions. So we are looking at some lifesavings, clearly, in the crash mode that those systems are designed to operate in. We continue to upgrade and update our estimates of effectiveness with analyses as more and more air bag vehicles get on the roads and we can refine them. But you are correct, those were our latest projections.

Senator BRYAN. That translates not only in terms of the human equation of saving lives and reducing serious injury, but we are talking about millions and millions of dollars in terms of medical and hospital bills, lost time on the job, and potential permanent disabilities, are we not, in addition to just the numbers of fatalities and the number of injuries, looking at that in terms of raw data?

Dr. MARTINEZ. Absolutely, sir. Actually, the other thing is that a lot of these—we focused on the head injuries and spinal injuries—are paid for by Medicaid and Medicare. One of the interesting things is about Medicare. For example, if you find someone who is

fairly young, and they have a spine or a head injury and they have been disabled long-term, they move on to the Medicare rolls, so that is cumulative. This can have an effect both in long-term and short-term costs.

Senator BRYAN. Your point being, Dr. Martinez, it is not only a potential financial impact to the individual, but all of us as taxpayers have an interest in that?

Dr. MARTINEZ. We are all in this together, sir. We are all in this together.

Senator BRYAN. Medicaid and Medicare are being funded by tax dollars.

Dr. MARTINEZ. Yes, sir.

Senator BRYAN. Either a combination of Federal or State dollars, or strictly Federal dollars.

Dr. MARTINEZ. Yes, sir. We believe that many of these injuries are preventable.

Senator BRYAN. So I take it that at this point you are not recommending that any change in the standard itself that currently exists with respect to deployment of air bags be made, is that correct?

Dr. MARTINEZ. We have not made any recommendations at this point. However, we have put out I think a fairly comprehensive request for comments, to ask what should be done, what can be done, and asked that people quantify those tradeoffs. Our role here is to try to focus on science and to understand, if you change one thing, what do you get for it, and do you cause new adverse effects or do you cause increased benefits?

Our whole goal here is to maximize the benefits and, as this number of air bags in the fleet goes up, to minimize those adverse effects. So we are asking everyone to give us as much information as they possibly can.

Senator BRYAN. Well, you were telling us a little bit of some of the engineering research and looking at new designs. What length of time do you think it will take to get through that process?

Mr. BOEHLY. Senator Bryan, the companies are very actively pursuing these smart air bags. And, as Dr. Martinez has said, trying to look at smart air bags is a very tough issue. In the front seat of a car, you have a driver and you have a passenger. Trying to detect the size of that driver and passenger, the weight of that occupant, location on the seat, the configuration of the seating position, legs crossed, is the occupant reading a newspaper—very difficult to make those kinds of analyses.

You also then would have to have some type of an algorithm that said, on the basis of all this information I now have detected about where this occupant is, what should I do? Should I fire the air bag with full force? Should I have a staged inflation that is going to perhaps have a slow onset rate, followed by a more punch-out of the bag, if you will?

These are very complex issues.

They also have to go in many millions of cars and be reliable. They have to be reliable in Senator Pressler's State. They have to be reliable in your State, looking at the weather conditions we have there, of course, in the South; in the far North, where it is cold.

They have to work over a period of years. They have to be design verified.

So I think, to answer your question, we are looking for that kind of technology to emerge, but it is going to be probably 4 or 5 years before we start to see that in production motor vehicles.

Senator BRYAN. My final question, again, to put this into some kind of context, a motorist ought to use his seat belt?

Dr. MARTINEZ. Absolutely. You know, it is the most effective piece of equipment in the car. The air bag does work very well, as we have said, in frontal crashes. But the world is not that simple. We have rollovers. We have side impacts. We have rear impacts. We have offset impacts. So that seat belt is very, very important. Not only does it keep you in the car, it protects you from impact inside the car and it keeps you in position to maximize the benefits of the air bag.

Senator BRYAN. The combination of the seat belt, when properly used, and the air bag, is really the safest way to drive, whether to and from work or to drive long distance, vast distance of miles, as Senator Pressler and I do in our respective States?

Dr. MARTINEZ. Overall, Senator, that is our opinion, yes, sir.

Senator BRYAN. Thank you very much.

The CHAIRMAN. Thank you.

Following up on some of those questions, let me ask this. Pickups are often the family's sole vehicle in my State of South Dakota. What is NHTSA's planning in terms of the possible turnoff switch for passenger-side air bags? Is that wise? I understand passenger-side air bags will be required by about 1998. What are the safety dynamics of the cut-off switch in pick-ups?

Mr. FELRICE. Mr. Chairman, our current regulations allow—do not require, but allow—a manual switch to turn off a passenger air bag in certain motor vehicles, particularly those that do not have adequate space in the front seat or, as in pickup trucks, do not even have a back seat. Therefore, it prevents rear-facing infant restraints from being put in the rear seat. That rule is in place. It is already effective. It stays effective for passenger cars until model year 1998, and pickup trucks until model year 1999.

As part of our current effort in analyzing this whole issue, we did seek public comment on whether we should extend or enlarge that allowance. We are in the process, right now, of analyzing those comments and reaching a decision on what we should do on that particular issue.

The CHAIRMAN. I understand that there is a higher rollover rate with some of these four-wheel-drive utility vehicles that are so popular. In fact, we drive a Blazer. But how do air bags function? Is there a higher danger, when there is a collision, where these vehicles roll over?

Number 2, how do air bags function in the circumstance in which you do not have a head-on collision, but, the vehicle rolls over from turning too fast or it rolls over from being hit at an angle? How do air bags function in these instances?

Dr. MARTINEZ. I will take both of those questions. The sport utility vehicles are raised off the ground. I think you know, during this winter, we saw that that vehicle was used a lot in our snow. That higher center of gravity does make them more likely to roll over.

We have also found that there is no correlation, though, between their stability and their rollover in the real world, because the driver makes such a difference in those cases.

One of our concerns is that sport utility vehicles are being bought in increasing numbers by these younger drivers. The concern there is that these drivers have such a low seat belt use. In the rollover configuration, there is centrifugal force which throws you out the window, essentially, just like if you were spinning a yo-yo.

So the air bag is not designed to minimize the dangers of a rollover crash. The seat belt is actually the most important piece of equipment with that. We are concerned, again, about that low seat belt use. We think that the focus of this coalition to increase seat belt use, especially in some of these hard-to-reach groups, which will make a dramatic difference in that.

The CHAIRMAN. With the new research and new technology that might come online with air bags not only coming out from the front but from the side, do we envisage a much safer vehicle in the future? What is the next step after air bags from the front?

Dr. MARTINEZ. Well, it is interesting, we did not pass a regulation about air bags from the side. Essentially, what we did was put a performance standard. It said this dummy is our best guess of what it takes to severely injure somebody, and you must keep down the forces generated against that dummy.

The manufacturers, I think, over the years, have increasingly put resources into safety, as have the sub-manufacturers, the component manufacturers. We have seen some very innovative and creative ways to minimize those forces.

Side impact air bags have been one way. We have seen some interesting designs in how padding interacts inside the side of the car. So we are hoping that this trend toward increased safety from creativity and innovation continues.

The CHAIRMAN. I want to revisit one of my earlier questions again, because I find it philosophically very fascinating that if there is a train wreck or a plane crash, we quite correctly go to work right away and hold hearings, and there is a great outcry in the press, and the public is gripped with this situation. I imagine because passengers are just sitting there, and are not in control as with their own vehicle. Consequently, they feel helpless, and we should be very concerned.

But if you look at the numbers of people killed or maimed in car crashes the numbers are astronomically greater. We seem to accept this, to some extent. I certainly do not accept it. There are a lot of technological things we could do in terms of tougher licensing, and I suppose, in terms of the speed vehicles move. Of course, theoretically, if you put everybody in a tank and drove them 5 miles an hour, you would have much greater safety. Obviously, there are tradeoffs.

It just seems that losing 41,000 people a year in car accidents, almost as many as we lost in the whole Vietnam War, should not be acceptable.

Is it the fact that people like to be free in their cars that keeps people from accepting any more restrictions? What is it?

Dr. MARTINEZ. Well, you know, people ask me why a physician would end up at the Department of Transportation, and my answer

is the same as Willy Sutton, the bank robber, when they asked him why he robbed banks, "Because this is where the money is." This is really the leading cause of death. I agree with you, I think we need to wake up a little bit on this.

In my own vocabulary, I do not use the word "accidents." I use the word "crash." An accident implies these things are acts of God. They are not predictable and preventable. With plane crashes, with railroad crashes, we do not accept that. We have this real fear of that, and we want somebody to do something about that.

Where I sit in this chair in my office, we have a death every 13 minutes and a major injury every 11 seconds. It is just totally unacceptable. So we are focused on this. We are trying to raise the awareness.

However, when you drive your car, you do not feel that. You do not feel drunk driving. You do not feel speed. You do not feel the crashes. So we need to recruit more people in this, and make people understand that these are predictable and preventable crashes, which are occurring. As I said, every 13 minutes, someone is dying.

We looked at this in a comprehensive way, three ways. We looked pre-crash, before the crash, things we can do to prevent the crash to begin with, licensing, speed limits, all these things; during the crash, which is our safety standards; and then post-crash, which is why we had the emergency medical services started from the Department of Transportation.

We are taking advantage of the health care debate the last few years so that we can engage others to see that this is part of their problem, too, to ask them to have some ownership and to address—put resources into it.

As you know, I have been going after the house of medicine. It is a big industry in this country. Yet, we spend a lot of money on treatments we are not so sure make a difference, and a very small amount of our money on prevention. We are trying very hard to get them to go past the hospital doors and into the community, and not wait for somebody to be injured but to prevent the injury. We think that in the next 5 to 10 years—actually, shorter hopefully—we will be making major differences in how communities and States view this problem.

The CHAIRMAN. This next question is not necessarily on air bags, but on car safety. After spending 14 months of my life on telecommunications, I cannot resist asking how safe is it for someone to be talking on a phone and driving a car?

Dr. MARTINEZ. That is a very good question. One of the things people talk about, they talk about the Autobahns a lot, and what people do not point out is, there is no signage allowed off the side of the road on the Autobahn because they do not want to distract you. There are a lot differences between the Autobahn and here in the United States, but we have tried to look at that issue. I will ask Mr. Boehly to address that.

Mr. BOEHLY. Thank you, Mr. Chairman. We in fact are looking at that as we speak. There is a State, Oklahoma, that interestingly enough codes that particular information on its police report. That is, was a cellular phone in use, so this State will allow us to do the type of analysis that you are asking the question about. That is, if you look at the role of the cellular phone in crash occurrence,

can you find some data that would suggest they have some effect, no effect, or a dramatic effect?

I can tell you that we are asking the contractors doing that study for us to come in in the next several months and let us know what they have done, let us know their methodology, and we hope to have some results on that this summer.

The CHAIRMAN. I would like to try to clear up some confusion about the required frequency of the Department of Transportation's reports to Congress on these issues.

I understand NHTSA believes it is required under section 2508 of the ISTEA legislation to report to Congress every 2 years. Consequently, your agency filed a report to Congress in January 1993. Very recently, you filed a second report to Congress. If the reports are required every 2 years, this report is approximately a year late.

Additionally, section 2805 of ISTEA and the intending joint explanatory statement of the conference committee both indicate these reports shall be biannual.

Now, where do we stand on that confusion, is there a reason behind this, or is there no confusion?

Mr. BOEHLY. Let me talk first about the lateness of the first report, Mr. Chairman.

The issue of addressing airbags, as we have talked about this morning, the effectiveness of airbags is a very complex one. We are now seeing, as we talked again this morning, more and more airbags are entering into the fleet.

We tried to do very robust, scientific, statistical analyses. We wanted to wait for enough data so that we could provide something to the Congress that has some statistical meaning to it, so in large measure this was the reason for the tardiness of this report.

I can assure you, given the fact that more and more airbags are out there now, that we fully expect to be able to meet the timeframe established in the legislation.

Dr. MARTINEZ. Just to amplify on that, in doing the research on that, as the airbags come into the fleet, we have more and more numbers, we can do the studies faster.

When you begin to go down and look at some of the basic questions that we think the Congress would want to know, if you end up with too few crashes in there, then you really do not have statistical data, and so we waited to get a greater number of crashes in there.

Mr. DUBBIN. Senator, Mr. Chairman, if your question is whether it is every 2 years or every 6 months, the ISTEA language, as you indicate, uses the word, biannually, and I think in common parlance, most people think of the word, biennially. There would be absolutely no question that is every 2 years. Were someone to ask for something every 6 months, that is semiannually, and so clearly, whatever biannually means, it is a lot closer to every 2 years than every 6 months.

When the language was recodified, the 6 months was included in the recodification, but when we went back to staff to ask that question, they made it clear they were expecting it every 2 years.

The CHAIRMAN. We may have a question or two in follow-up. Let me ask just one more. We have mentioned that they have just re-

cently introduced side impact airbags to the market. Are you aware of any adverse effects the side impact airbags could have?

Dr. MARTINEZ. We have not had that many exposures.

Having them in the market and having them in a crash are two different things. Most of this is done off of dummy testing.

We are not aware at this point of any major effects of that, but I think based upon the questions we have raised with passenger side airbags, I am fairly certain to say that most of the manufacturers are really looking at that to make sure there are none.

Mr. BOEHLY. I cannot add anything to that. Again, Mr. Chairman we are not aware of any. We will continue to look at that to see if it would arise.

The CHAIRMAN. Senator Bryan, do you have anything further?

Senator BRYAN. Just a couple, Mr. Chairman.

Dr. Martinez, what does the data show with respect to seatbelt usage? Does it vary widely from State-to-State and region to region, and to what extent does State law have any impact on the overall usage?

Dr. MARTINEZ. We have some graphics. I might be able to address that with—as you know, 49 out of the 50 States have seatbelt laws. One does not. We divide those laws into two groups—put the other graphic on first.

Two groups, the primary law and secondary law. The secondary law basically says we cannot stop you to check for having a seatbelt; and, in some States they say we cannot stop you unless you do one of the following things. So there are things you can do and things you cannot do before you get a ticket for not having a seatbelt.

Then there are the primary seatbelt laws. There are only 10 States that have primary seatbelt laws, which means you can be stopped for not wearing a seatbelt, and they can give you a citation at that point.

If I show the next graphic real quick you will see that those States with primary belt laws have the highest seatbelt use rate.

We often talk about other countries. We talk about other countries having higher seatbelt use, but you do not have to leave our country to find high seatbelt use rates. It is over 80 percent, 85 percent, actually, in California, it is over 80 percent in North Carolina. These are States which have primary laws, which normally increase the seatbelt use rate by 15 percent. These States have fairly good public information with this, and enforcement with this, so we think that in this country you can do that successfully.

There are States that have seatbelt use down in the 40 and 50 percent range.

Senator BRYAN. What accounts for that?

Dr. MARTINEZ. It goes back to Mr. Pressler's question of where do we put this in society, where do we put this as affecting us all?

We often hear people talk about wearing a seatbelt as affecting no one except them; in that case, it is a right, but not wearing a seatbelt does not give people freedom to harm other people—in other words, what I do affects others, then you begin to see people change. I find the American people very smart, that if you show them the consequences of actions, they begin to do something about it. We did that with drunk driving.

When I grew up, Foster Brooks was on TV, and Frank Fontaine was on TV, I did my impression of Dean Martin with a little glass. People began to look at the consequences of drunk driving. All of a sudden, we had major focuses on the problem and began to reduce drunk driving. There are other social changes that we have done, after understood the consequences.

We need to do a better job with seatbelts. We need to do a better job with speed and some of the other issues.

Senator BRYAN. I think we all acknowledge that the Federal Government is not the font of all wisdom. Tell us what you believe the appropriate role of the States are in terms of improving auto safety.

Dr. MARTINEZ. The States really have, especially in this environment, the responsibility, the right to set speed limits and to set seatbelt use, what-have-you, but with that right comes accountability and responsibility.

One of the things we are trying to do with the States is to have them look at their own data so they can make their own constituents and citizens aware of who is paying for this, what the problems are, and some very simple, best practice solutions that we helped move from State to State, such as primary seatbelt laws, that they can bring into their own community and see the positive effects of that.

You know, our Safe Communities program really goes into the local level. What it says is, using your data, you can find your problem from your community, and as the Federal Government we want to be a partner to help you solve that problem. Then you see the benefit you get in your own communities, and we are actually very excited about that.

We have automobile dealers more involved now. We have businesses more involved now. We have major league sports coming in more and more. We have schools on board. So I think that we are trying to take advantage of this increased empowerment within the communities.

Before the NHS bill rapidly moved all these rights to the States, we had already begun to attack this problem at the local level. Because we are talking about 67 percent seatbelt use nationally, or 40 percent drunk driving nationally, the question is, can you increase it just at the national level or do you have to go into the local communities to make the difference. We believe that a partnership is the best way to go.

Senator BRYAN. Thank you very much. Thank you,

The CHAIRMAN. Thank you very much to this panel.

I would now call forward panel 2, Dr. Richard Klimisch, vice president, Engineering Affairs Division, American Automobile Manufacturers Association, Mr. Brian O'Neill, president, Insurance Institute for Highway Safety, Mr. George Parker, vice president, Engineering Affairs, Association of International Automobile Manufacturers.

Gentlemen, we welcome you, and why don't we begin with Dr. Klimisch.

STATEMENT OF DR. RICHARD KLIMISCH, VICE PRESIDENT, ENGINEERING AFFAIRS DIVISION, AMERICAN AUTOMOBILE MANUFACTURING ASSOCIATION, 1401 H STREET, N.W., SUITE 900, WASHINGTON, D.C. 20005; ACCOMPANIED BY VANN WILBER, DIRECTOR OF VEHICLE SAFETY

Dr. KLIMISCH. I am Dick Klimisch. With me is Vann Wilber, director of vehicle safety for the American Automobile Manufacturers Association. On behalf of our member companies, Chrysler, Ford, and General Motors, we welcome his hearing, because we think it can help the public understand how the risk associated with airbags can be substantially reduced.

The crash protection benefits are well-established. The industry has fully embraced this technology.

The CHAIRMAN. If you could, pull the microphone over a little bit.

Dr. KLIMISCH. Installation is well ahead of congressional mandates. As the population of airbags and vehicles increases, so does the body of evidence that they are highly effective in helping to reduce fatalities in severe frontal crashes.

Unfortunately, this demonstrated high level of effectiveness is accompanied by some potential unwanted side effects, such as the injuries from occupants that result from interaction with airbags. The potential for injury is related to the proximity of the occupant to the airbag when the airbag deploys, and the force of the deployment.

The risk of injury is greatly aggravated by the occupant not wearing a safety belt. It is also aggravated by the current unbelted test requirement, FMVSS–208, which indirectly dictate the energy level of airbags, requirements that were developed at a time when safety belt usage in the U.S. was only 10 to 15 percent as compared to the current level of 67 percent.

Although serious injuries and fatalities related to airbag inflation are at this time rare events, the risk is, of course, proportional to the rapidly expanding population of vehicles equipped with driver and passenger airbags. Clearly, occupants at greatest risk are the unrestrained occupants of any age, and children in rear-facing infant seats who are positioned adjacent to the front passenger airbag.

The potential for injury has been recognized and reported for many years. Research beginning in the 1970's demonstrated the potential for injury if occupants came in contact with an airbag when it inflates.

Manufacturers have studied airbag interaction with occupants exhaustively, in a determined search for better ways to manage the necessarily high energy of the deploying bag. As a result, many improvements have already been found and implemented in vehicles. However, given the current technology and the regulatory constraints, we are not aware of countermeasures available today that would substantially reduce or eliminate the risk of injury from occupant interaction with airbags.

We are optimistic that highly reliable advanced technologies eventually will be developed to reduce the risk. However, these technological aids are still some years away. Meanwhile, the population of vehicles with airbags is growing rapidly, and is expected to reach 150 million vehicles in the next decade. It is clear that

near-term actions are urgently needed, and that Government, industry, and the public each have a role.

Our recommendation is first to increase seatbelt and proper child safety belt use. AAMA has a long history of supporting mandatory seatbelt usage laws. Our support of Traffic Safety Now and the American Coalition for Traffic Safety are well-known, and we know that with proper legislation and educational efforts, safety belt usage can be increased.

We need to reach usage rates of 90 percent or higher, rates that actually have been approached in some States and achieved in many countries, including Canada. We need to increase also, of course, the proper use of child safety seats.

In response to NHTSA's call to action at its January 16 conference on safety belts, airbags, and passenger safety, AAMA and its members, along with AIAM and its members, proposed a 1996–1997 $21 million effort, with approximately half the funds provided by industry, first to better inform motor vehicle users of airbag related injury risks and the precautions to take to reduce those risks, second, to encourage a sense of personal responsibility for motor vehicle occupant safety, and third, to increase the proper use of safety restraints by children and adults through legislation, enforcement, and public education.

To amplify these last three, with regard to legislation, you have heard only 10 of 49 States have primary enforcement. GAO recently reported that States with primary enforcement have belt use rate 15 percentage points higher than States with secondary enforcement.

With regard to enforcement, we know that highly visible safety belt use programs, whether in States with primary or secondary use laws, have demonstrated the potential to substantially increase belt usage.

In North Carolina, a primary law State, usage increased from 65 to over 80 percent in a 3-month period with a well-organized, highly visible enforcement program which was strongly supported by auto insurers. Equivalent results have been obtained elsewhere.

With regard to public education, obviously, increased public awareness of the benefits of safety belt and child safety seat use is needed as well as better information for motor vehicle users on airbag injury risks.

Our $21-million proposal in response to NHTSA's call to action suggested a coalition in which NHTSA would provide the leadership that would focus and coordinate the activities of all interested safety organizations. We strongly recommended to NHTSA that the auto insurance companies, because of their financial interest and their long history of airbag advocacy, be encouraged to participate on an equal basis with the auto industry.

We also urge the committee to support the formation of this coalition and its goals, and also to help provide leadership in encouraging States to adopt primary safety belt use laws.

Our second recommendation is to fine tune the airbag regulation. It is clear that due to the near term absence of advanced technologies to reduce potential airbag injury, short term help will only be accessible through adaptation of the current regulations that indirectly govern the energy levels of the airbag.

It is our strong belief that regulations must provide the necessary flexibility to ensure that better designs can be used to help assure improved overall occupant safety, and I cannot emphasize that, the importance of flexibility in allowing creativity and innovation to operate. Accordingly, we have been working with NHTSA to help identify the regulatory adaptations that will produce the near-term help.

Finally, the complexity of this situation is truly daunting. There will likely be no technological magic solutions. That is, there will always be tradeoffs. Every change will likely reduce risks for one group but increase risks for another.

The question will always be, what is the right balance, but there is no question that seatbelt use will be the most important countermeasure now and into the future.

We thank the committee for your interest in this matter, and we will be pleased to answer questions.

[The prepared statement of Dr. Klimisch follows:]

STATEMENT OF DR. RICHARD KLIMISCH

Mr. Chairman and Members of the Committee: My name is Dr. Richard Klimisch and I am Vice President for Engineering Affairs of the American Automobile Manufacturers Association (AAMA). On behalf of AAMA and its member companies, Chrysler, Ford and General Motors, I appreciate the opportunity to present these views concerning air bags and occupant protection.

AAMA welcomes the attention of the Committee in addressing this very important societal problem. This hearing adds visibility which can help the public understand that there are certain potential risks associated with air bags that can be substantially reduced by actions available to vehicle occupants.

In the Committee's letter of invitation, you requested that we focus our testimony on the trade-offs involved in present air bag regulations and that we state any recommendations we may have for modifying existing regulations. My testimony today will address these issues.

The crash protection benefits of air bags are well established. The industry has fully embraced this technology and installation is well ahead of Congressional mandates. As the population of air bags in vehicles increases, so does the body of evidence that they are highly effective in helping to reduce fatalities in severe frontal crashes. The most recent estimates by the National Highway Traffic Safety Administration (NHTSA) in their second biennial report to Congress on the Effectiveness of Occupant Protection Systems and Their Use, indicate that air bags are 15–18% effective in reducing fatalities in all frontal crashes.

Unfortunately, this demonstrated high level of effectiveness is accompanied by some potential unwanted side-effects, such as injuries to occupants that result from interaction between the occupant and the air bag during the air bag deployment event. The potential for injury is related to the proximity of the occupant to the air bag when the air bag deploys.

The risk of injury is greatly aggravated by the occupant not wearing a safety belt. It also is exacerbated by the current unbelted test requirements of FMVSS #208, which indirectly dictate the minimum energy level of air bags—requirements that were developed at a time when safety belt usage in the U.S. was only 10–15 percent as compared to the current reported level of 67 percent.

Although serious injuries and fatalities are at this time rare events, the risk is of course proportional to the rapidly expanding population of vehicles equipped with driver and passenger air bags. Although some air bag fatalities have been reported for restrained occupants, the occupants at greatest risk are unrestrained occupants of any age and children in rear facing infant seats that are positioned adjacent to the front passenger air bag.

The potential for injury has been recognized and reported for many years. Research beginning in the 1970's demonstrated the potential for injury if occupants come in contact with an air bag when it inflates. Manufacturers have studied air bag interaction with occupants exhaustively in a determined search for better ways to manage the necessarily high energy of the deploying bag. As a result, many improvements have been found and implemented in vehicles. However, given the current technology and regulatory constraints, we are not aware of any single counter-

measure or combination of countermeasures available today that would substantially reduce or eliminate the risk of injury from occupant interaction with air bags.

We are optimistic that highly reliable advanced technologies eventually will be developed that may be beneficial in reducing the risk of injury; however, these technological aids are still many years away. Meanwhile, the population of vehicles with air bags is growing rapidly and is expected to reach 150 million vehicles in the next decade. However, the challenge of addressing these potential side effects is not NHTSA's alone. Many organizations and individuals must play a role in accomplishing reductions in this societal problem.

It is clear that near term actions are urgently needed and that government, industry and the public each have a role.

AAMA Recommendations

Increase safety belt and proper child safety seat use

Wearing a safety belt is the single most important action that can be taken to improve occupant safety—a recent NHTSA study concluded that 3 out of 5 unbelted motorist fatalities could have been avoided with the use of a safety belt. And air bags are most effective when used in combination with belts and were designed as a supplement to safety belts.

AAMA has a long history of supporting mandatory seat belt usage laws and we know that with the proper legislative and educational efforts, safety belt usage can be increased. In the late 1980s and early 1990s, AAMA and its members, through Traffic Safety Now, undertook a major multi-year $100 million effort in cooperation with NHTSA to promote state enactment of safety belt use laws. Our members continue to undertake a number of activities to promote safety belt use, including support for the American Coalition for Traffic Safety.

Today only one state (New Hampshire) is without a belt use law and national safety belt usage is reported by NHTSA to be 67%. This, however, is not good enough. We need to reach usage rates of 90% or higher—rates that have been approached in some states and achieved in many other countries including Canada, and we need to increase the proper use of child safety seats.

In response to NHTSA's "Call to Action" at its January 16–17 conference on "Safety Belts, Airbags, & Passenger Safety," AAMA and its members, along with AIAM and its members, proposed a 1996/97 $21 million effort—with approximately half the funds provided by our industry—to: (1) better inform motor vehicle users of air bag related injury risks and the precautions to be taken to reduce those risks; (2) encourage a sense of personal responsibility for motor vehicle occupant safety; and (3) increase the proper use of safety restraints by children and adults through legislation, enforcement and public education.

Legislation

Today only 10 of the 49 states with safety belt use laws have primary enforcement. This means that in the other 39 states, a driver can not be stopped for failure to wear their safety belt. A driver can only be stopped if the officer observes some other traffic violation before he or she could be ticketed for failure to buckle up. Unfortunately, this is sending the wrong message to both the police and the driving public. We need to enact primary enforcement measures in all states.

The General Accounting Office, in its recently released report "Comprehensive State Programs Offer Best Opportunity for Increasing Use of Safety Belts" points out that states with primary enforcement have a belt use rate that is 15 percentage points higher than states with only secondary enforcement.

Enforcement

We know that highly visible safety belt use enforcement programs, whether in states with primary or secondary use laws, have demonstrated the potential to substantially increase safety belt usage. In North Carolina, a primary law state, usage increased from 65% to over 80% in a three month period with a well organized, highly visible enforcement program which was strongly supported by auto insurers. Equivalent results have been obtained in Canada, various Texas cities, and Elmira, New York. AAMA concurs with NHTSA that if all states were to conduct highly visible enforcement efforts only, national usage could increase to approximately 80%.

Public Education

Increased public awareness of the benefits of safety belt and child safety seat use is needed, as well as better information for motor vehicle users on air bag injury risks. Public education is a critical element for the successful implementation of both primary use laws and increased enforcement of existing child safety seat and safety belt laws. A concentrated communications effort must surround any legisla-

tive or enforcement effort. It must be tailored to appeal to the targeted audience and precede any legislative or enforcement effort. It must also continue during and after the program.

Coalition Structure

Our $21 million proposal to NHTSA suggested the formation of a coalition where NHTSA would provide the leadership that would focus and coordinate the activities of all interested safety organizations. In addition, there would be a managing committee that would consist of the major financial contributors to the program. We strongly recommended to NHTSA that the auto insurance companies, because of their financial interests and their long history of air bag advocacy, be encouraged to participate on an equal basis with the auto industry. We are very hopeful that the insurance industry will register support for this program so that this important activity can begin.

AAMA urges the Committee to support the formation of this coalition and its goals. In addition, we believe that Congress can and should play an active leadership role in encouraging states to adopt primary safety belt use laws and achieve higher belt and child safety seat use rates. Actions that should be considered include incentive grants to states which pass primary belt laws or achieve certain belt and proper child safety seat use targets or, if there is the will to take stronger action, imposition of highway fund sanctions on states which do not pass a primary law by a certain date. Although the trend has been against the sanction approach recently, we note that Congress used this mechanism in the National Highway System legislation last year for state adoption of "zero tolerance" legislation.

The benefits of these laws are well documented and we look forward to working with the Committee to address this societal issue.

Fine tune the air bag regulation

It is clear that due to the near term absence of advanced technologies to help reduce the potential for air bag injury, short term help will be accessible only through adaptations of the current regulations that indirectly govern the energy levels of air bags. It is our strong belief that the regulations must provide the necessary flexibility to ensure that better designs can be used to help assure improved overall occupant safety. Accordingly, we have been working with the NHTSA to help identify the regulatory adaptation that will produce near term help. We have a full appreciation of the magnitude of the task and we applaud the level of attention currently being brought to the task at the NHTSA.

We thank the Committee for your interest in this matter and would be pleased to answer any questions.

The CHAIRMAN. Mr. Brian O'Neill, president, Insurance Institute for Highway Safety.

STATEMENT OF MR. BRIAN O'NEILL, PRESIDENT, INSURANCE INSTITUTE FOR HIGHWAY SAFETY, 1005 N. GLEBE ROAD, ARLINGTON, VIRGINIA 22201

Mr. O'NEILL. Mr. Chairman, what I would like to do with your permission is to have my complete statement entered into the record, and I will just summarize the key points of the testimony.

We have already heard that airbags are very effective. They are saving lots of lives and preventing a lot of serious injuries, but what we are here today to talk about are the unfortunate side effects of airbag deployments.

As you have already heard, the overwhelming bulk of the adverse side effects of airbags are minor injuries, and only a tiny fraction of the injuries produced by airbags are serious or fatal. These are obviously important, and we need to do something to reduce this risk, and it is important to understand that these injuries are caused by the energy involved in rapidly inflating the bags.

All motor vehicle crash injuries are caused by mechanical energy. It is when we experience energy in rates and amounts that our body cannot tolerate that we become injured. Airbags are designed to prevent these injuries by creating an energy-absorbing buffer to

decelerate occupants more gradually than they would be decelerated otherwise.

The problem is that significant energy is required to inflate an airbag in the fraction of a second necessary for it to be in a position to provide that protective buffer, and if an occupant finds himself or herself in the path of a deploying airbag, there is a chance that that person can be injured by the energy of the bag.

We have already heard groups at particular risk include motorists who are driving with their chest very close to the steering wheel, or for some other reason they are slumped over the steering wheel.

Unbelted occupants, both drivers and passengers, are at risk because there can be pre-impact events that will put them out of position, whether it be braking or jumping a curb, that may put them very close to the airbag when it begins to inflate.

We have also heard today about the problem of rear-facing infant restraints if they are placed in front of a passenger airbag.

It is important to remember that seatbelts can and do produce occupant injuries just as airbags can produce occupant injuries. The main difference between injuries caused by airbags and those caused by safety belts, however, is that belt injuries result from the energy of the crash itself, and they normally only occur in crashes where there is significant crash energy.

Because many of the airbag injuries result from the energy of the bag itself, they can and do occur in relatively low severity crashes where injuries would otherwise not occur, and that makes them particularly noteworthy and particularly troubling.

As you have already heard, we believe there is no single problem, or no single solution to this problem. We need improved airbag designs, as well as we need effective programs to increase both safety belt use and the correct use of infant and child restraints.

We think there are a number of technological improvements (some of which are already happening and some of which need to happen) that can reduce this risk. We need to see improved inflators and improved sensors to eliminate some of the unnecessary deployments that are occurring in today's crashes.

Manufacturers around the world are already working to improve airbag crash sensors, and I believe that with better and better sensor designs, more of the unneeded low severity crash deployments will be eliminated, and so will the risk, obviously, of an inflation injury.

We have already heard that improvements in the way bags are folded, and as a result the way they unfold, can also reduce the risk of an inflation injury. Those are changes that are already happening.

Another change that should happen, that is somewhat constrained by the current requirements of FMVSS–208, is the adoption of lower energy inflators. If you reduce the energy level of the inflators in the bags, by definition you are reducing the risk of an injury caused by the energy of the inflator.

Obviously, the question is, how much energy can we take out of a bag without compromising its protective capability? If you have no energy, you have no bag, and you have no protection. That is taking it to the extreme. We believe, based on the research we have

done at the Institute, that you can reduce the inflator energy rather significantly without compromising the protection offered by airbags.

In fact, we believe that unbelted occupants can actually gain protection from lower energy inflators, because so many unbelted occupants finish up in improper positions during the pre-impact crash events.

We think that the current unbelted test requirements of FMVSS–208 are improperly constraining the design freedom of the manufacturers. We believe it is important and urgent for NHTSA to relax those requirements in some way to give the manufacturers additional design freedom. We think that the manufacturer design freedom should not be constrained. They should be given more design freedom to design effective but lower energy airbag inflators.

We have already talked about the need for smarter systems and the expectation that we will get smarter systems. Smarter airbag systems promise to improve the situation with respect to rear-facing infant restraints that some parents, unfortunately, continue to place in front of passenger side bags. Some manufacturers are very close to implementing systems that will automatically deactivate a passenger bag in the event that a rear-facing infant seat is placed in front of such restraint.

Obviously, longer term, we are going to see, as we have already heard, smarter and smarter airbag systems that will increasingly reduce the risk. In the meantime, we have to work aggressively to change driver and occupant behavior. We need to get more adults buckled up. We need to get more children properly restrained in the rear seats.

I think it is very important to understand that information and education alone will not be sufficient to resolve this problem. Virtually every adult in the United States understands and acknowledges the benefits of wearing a seatbelt in a collision. Yet, about 35 to 40 percent of adults still choose not to buckle up, despite the fact that it is against the law, and we know without the laws, even more motorists would choose to buckle up.

They are not doing so because they lack the knowledge. They are doing so for a series of other complicated reasons, including the fact, for example, that many people do not believe that they themselves are going to be in a motor vehicle crash. It is all those other people that need to buckle up, not me.

So we cannot rely on public information alone. We obviously, as you have heard already, need better seatbelt laws. We need primary enforcement of seatbelt laws, and we need specially targeted enforcement programs.

Insurers, together with the Institute, NHTSA, and the Governor of North Carolina and others, have been conducting a State-wide program for more than 3 years now in North Carolina to demonstrate effective strategies to increase belt use and to accomplish other highway safety objectives. This program has become such a success that North Carolina has become a model for the Nation.

We are currently getting ready to add something else to the North Carolina program. This is an effort specifically targeted at adults who are transporting infants and children that are improperly restrained. The objective is to greatly increase the number who

travel properly restrained. This will be the first State-wide enforcement and education program targeted at this problem, and we will be inviting auto makers to join with us in this effort.

Several automobile insurers met with Secretary Peña to discuss these issues on Friday last, and a number of these insurers, and we hope additional insurers beyond the small group that met on Friday, will be working with the auto makers and the U.S. Department of Transportation to find additional effective ways to address this problem.

Obviously, these initiatives take on special importance because, as we already heard, there are a number of cars already on the road with airbags. They are a major success. They are preventing many occupant deaths and serious injuries, but we need to address ways to reduce these unintended side effects. Thank you.

[The prepared statement of Mr. O'Neill follows:]

[The prepared statement of Mr. O'Neill follows:] (20 pages)

Statement Before the U.S. Senate Committee on Commerce, Science, and Transportation

On Air Bags

Brian O'Neill

March 7, 1996

INSURANCE INSTITUTE FOR HIGHWAY SAFETY

1005 N. GLEBE ROAD, ARLINGTON, VA 22201 (703) 247-1500

The Insurance Institute for Highway Safety is a nonprofit research and communications organization, supported by automobile insurers, that identifies ways to reduce motor vehicle crashes and their losses. I'm the Institute's president and, at this committee's request, I'm submitting for the record information from the Institute about air bag effectiveness, the problem of inflation injuries caused by air bags, and ways to reduce such injuries.

Air Bag Effectiveness

The purpose of air bags is well known by now — they work with safety belts to protect people in serious frontal crashes — and air bags are performing this purpose every bit as well as anticipated. They've inflated in hundreds of thousands of crashes so far and reduced driver deaths in frontal impacts by about 20 percent, a percentage estimated not only by Institute research[1] but also by the National Highway Traffic Safety Administration (NHTSA).[2] About 1,000 motorists' lives already have been saved, based on NHTSA estimates.[3]

Like other heralded breakthroughs in medicine and public health, air bags also cause unintended adverse side effects — occupant injuries and even some deaths.[4] The same is true of penicillin, for example, and of polio vaccine and many other lifesaving advancements. We view the side effects of these in the context of their much larger success in saving lives. This doesn't mean the deaths and serious injuries caused by air bags are inconsequential. They're relatively rare but definitely of consequence and worth every effort to reduce without seriously compromising air bag effectiveness.

Unintended Side Effects

Ninety-six percent of the adverse side effects of air bags are bruises, abrasions, and other relatively minor injuries — insignificant compared with the serious and fatal injuries air bags

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[1] Ferguson, S.A.; Lund, A.K.; and Green, M.A. 1995. Driver fatalities in 1985-94 air bag cars. Arlington, VA: Insurance Institute for Highway Safety.

[2] Kahane, C.J. 1994. Fatality reduction by automatic protection in the United States. Presented at the 14th International Technical Conference on Enhanced Safety of Vehicles. Munich, Germany, Paper No. 94-55-08.

[3] Federal Register 60:217, p.56554.

[4] Insurance Institute for Highway Safety. 1996. Medical successes often carry adverse side effects; air bags are no exception. *Status Report* 31:1 (attached). Arlington, VA: Insurance Institute for Highway Safety.

are preventing. Only a tiny fraction of air bag injuries are serious or fatal, and these are caused by the energy involved in rapidly inflating the bags.

All motor vehicle crash injuries are caused by mechanical energy interacting with the human body in amounts or at rates that exceed the threshold of human tolerance. Air bags are designed to prevent this by creating an energy-absorbing buffer to decelerate occupants more gradually. Thus, some of the occupants' energy is absorbed, and injuries aren't as likely to occur. However, significant energy is required to inflate an air bag in the fraction of a second necessary for it to be positioned to provide the protective buffer. This energy of an inflating bag can itself injure an occupant in its path, especially if the bag is in the beginning stages of inflation.

In severe crashes, most inflation injuries are acceptable tradeoffs because they're likely to be less serious than those that would have been sustained without the air bags. The inflation injuries of greater concern are those that occur in crashes of lesser severity in which it's possible no injury at all would have occurred without the energy of the inflating bag.

Most occupants in crashes of air bag-equipped cars aren't at great risk of injury from inflating air bags. But certain groups are at higher risk than others because they're more likely to be in the path of an inflating bag:

1. Motorists whose driving positions put their chests very close to steering wheels
2. Unbelted drivers and passengers who, during braking before an impact or other events before impact like running off the road or jumping a curb, may have moved very close to — even on top of — an air bag as it begins to inflate
3. Infants in rear-facing restraints positioned in front seats of vehicles with passenger bags

Some of these people in the path of an inflating air bag have physical characteristics making them more vulnerable to serious injuries — in particular, elderly people because they're more fragile and young children because of their lighter weights and smaller sizes.

It's useful to remember that safety belts can and do injure people, too. The main difference between the injuries caused by air bags and those from safety belts is that belt injuries usually occur in more serious crashes because the energy that causes them comes from the crash itself. Air bag injuries, on the other hand, occur because of the energy involved in inflating the bag. This means air bag inflation injuries can, and do, occur over a whole range of crash severities including some relatively low-severity impacts in which serious crash injuries would be unlikely.

No single measure will eliminate all inflation injuries. Improved air bag designs are needed. So are effective programs to increase both safety belt use and correct use of infant and child restraints.

Technological Improvements

Air bag designs can be improved. Some of these improvements already are being implemented, while others will take longer and/or require changing Federal Motor Vehicle Safety Standard 208, which specifies air bag performance requirements. Ways to improve air bags include the following:

Air bag sensors signal inflators to fill the bags with harmless gas. Today's air bag systems use a variety of sensor designs, many with two or more electromechanical devices located toward vehicles' front ends. These sensors measure crash severity to determine if air bag deployment is warranted but, because they're located so far forward, they can trigger inflation when localized crash damage occurs in their immediate vicinity rather than when crash severity exceeds the air bag deployment threshold. Such deployments aren't needed for occupant protection, but they do expose people to the risk of inflation injury.

Another limitation of electromechanical sensors is that there's only one deployment threshold. That is, one level of crash severity determines whether or not an air bag inflates. To ensure adequate protection for unbelted people, the threshold is set at a level at which injury risk among people using belts is very low. This means bags deploy in many crashes in which they aren't needed because occupants are belted. Institute analyses indicate that as

many as half of the air bag deployments in crashes involving people using belts aren't needed.[5] Designs exist that can eliminate such deployments, and Mercedes and BMW already are using them. These two automakers use a single, more sophisticated electronic sensor that's located inside the occupant compartment and connects to safety belt buckle sensors. When this kind of air bag sensor detects that front-seat occupants are using belts, it triggers air bag deployment at a higher threshold than when occupants are unbelted.

There's another advantage compared with electromechanical sensors. Because the single-point electronic ones are located in the occupant compartment instead of toward the front ends of vehicles, they don't trigger unnecessary deployments caused by localized impacts near the sensors. For these and other reasons, improved sensors can eliminate large numbers of unneeded deployments.

Air bags are folded underneath their covers where they stay unless, and until, they deploy in a crash. When inflation begins, the cover is designed to tear in specified directions, and the bag unfolds as it inflates. How this tearing and unfolding occur — that is, in what directions — affects the risk of occupant injury from inflating bags. Manufacturers increasingly are developing and using sophisticated tear and folding patterns that direct the energy of inflation in ways that reduce injury risk from inflating bags. It's particularly important to design bags that, early in inflation, expand to the sides as well as toward occupants.

Reduced-energy inflators offer other opportunities for improvement. It's the energy of inflating air bags that can cause injuries, so reducing this energy obviously would reduce risk. The question is, can some energy be removed from inflators to reduce inflation injury risk without reducing the protection afforded by the bags? It wouldn't do to remove too much energy, which would solve the problem of inflation injuries but also would leave occupants without effective air bag protection in crashes.

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[5] Insurance Institute for Highway Safety. Dec. 26, 1995. Comments to the National Highway Traffic Safety Administration on Federal Motor Vehicle Safety Standard 208, Docket 74-14, Notice 97. Updated Jan. 22, 1996.

unbelted people are both the ones the standard is intended to protect by constraining inflator energy levels *and* the group at greatest risk of inflation injury resulting from this energy. This paradox occurs because the unbelted test is a poor surrogate for many real crashes in which people are unbelted. The test simulates a simple 30 mph impact involving a properly positioned — though unbelted — occupant. But fatal crashes involving people without belts aren't this simple. The Institute's review[7] of cases from the National Accident Sampling System indicates that such crashes often involve multiple impacts and other events before the impact, so unbelted occupants often aren't properly positioned. They're out of position and, therefore, may be injured by the very air bag that would have protected them only if they had been positioned like the dummy in the compliance test.

Because the unbelted test is a poor surrogate for so many real crashes in which occupants are unbelted, it shouldn't be constraining air bag designs in the major way it does now.[8] NHTSA should put the highest priority on modifying the requirements of this test to allow manufacturers greater design freedom in choosing appropriate air bag energy levels. This would reduce inflation injury risk, and it would accomplish this without compromising the protection air bags afford.

Rear-Facing Infant Restraints

The air bag design improvements discussed above are intended to reduce the risk of inflation injury among all passenger vehicle occupants. Specific technology improvements also are needed to address the special problem of rear-facing infant seats. The auto industry is in the final development stages of systems that will automatically deactivate a passenger air bag when a rear-facing infant restraint is positioned in a vehicle's front seat. A variety of sensor technologies are being developed and tested, and it won't be long before we begin seeing such "smarter" systems.

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[8] There's one important air bag design characteristic resulting from the unbelted test requirements of Federal Motor Vehicle Safety Standard 208 — a characteristic worth preserving even if the standard is changed. This characteristic is the full-size air bag as opposed to the much smaller, so-called "Eurobag." We believe the full-size ones in cars sold in the United States provide superior protection, so changes in the unbelted test requirements should somehow ensure the continued use of the full-size bag.

To begin answering the question of whether inflation energy can be reduced without compromising protection, Institute researchers studied all 1989-93 crashes in NHTSA's National Accident Sampling System[6] in which drivers died in 1990 or newer vehicles with air bags.[7] Researchers were trying to determine whether any of the drivers died because air bag protection was insufficient — that is, whether any of the fatal injuries occurred because the available protective energy of the bags was used up. The clear answer is no. Most of the drivers sustained their fatal injuries in other-than-frontal impacts, including side impacts and rollovers. Other drivers died in frontal impacts because of massive occupant compartment intrusion — so massive that no restraint could be expected to prevent fatal injuries.

No deaths could be attributed to insufficient air bag protection. Researchers did find a few frontal crashes of moderate severity in which the air bags should have protected the drivers. Instead, because these drivers were very close to their air bags when inflation began, the energy of the inflating bags contributed to the fatal injuries. All but one of these drivers were unbelted.

Based on these findings, the researchers concluded that "reducing deployment energy would improve air bag effectiveness in relatively severe crashes as well as low-severity crashes, even for unbelted drivers."

Yet manufacturers seeking to reduce inflator energy encounter a problem. Energy levels in current air bag systems are largely determined by the unbelted test requirements of Federal Motor Vehicle Safety Standard 208, because it takes more energy to decelerate an unbelted test dummy compared with when a safety belt helps deceleration. The paradox is that

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[6] Crashes included in the National Accident Sampling System are small in number, but each one is investigated more thoroughly than most other crashes in the United States. They therefore provide researchers with detailed information on crash circumstances and occupant injuries.

[7] Lund, A.K.; Ferguson, S.A.; and Powell, M.R. 1996. Fatalities in air bag-equipped cars: a review of 1989-93 NASS cases. SAE Technical Paper 960661 (attached). Warrendale, PA: Society of Automotive Engineers.

In the meantime, there have been suggestions to allow — even require — manufacturers to install manual passenger bag cutoff switches for use by adults who insist on putting rear-facing infant restraints in front seats. Such switches, which currently are allowed only in vehicles in which infant restraints cannot be properly placed in the rear seat, have obvious potential for misuse. Plus, there's no reason to expect that adults who already fail to understand — or who ignore — warnings about the risk of infant restraints and air bags would use the switches correctly. The Institute therefore opposes extension of this option to all vehicles. It's a measure we believe would create more problems than it would solve.

"Smart" Air Bags

In the longer term, air bag systems will be capable of determining more than whether an infant restraint is present or whether occupants are using their safety belts. Air bags will be "smart" in a larger sense. They'll be capable of determining occupants' positions immediately before deployment and of tailoring air bag energy levels so they're optimum for these positions and the expected crash severity.

It's even possible that air bag sensors will be developed that can reliably anticipate crashes and crash severity milliseconds *before* impact begins. This would represent a huge advancement compared with today's air bag sensors, which require milliseconds *after* crashes begin to decide whether air bags should inflate. Because of the extra time, air bag inflation could be slower and, therefore, the risk of inflation injury could be substantially reduced.

Suppliers and automakers are working to develop "supersmart" air bag systems, but they obviously won't be in cars tomorrow.

Changing Motorist Behavior

Advancements in air bag technology — promising as they are in both the short and, especially, long term — don't solve the problem of people being injured in air bag-equipped cars already on the road. More than 33,000,000 passenger vehicles have driver-side air bags, and another 15,000,000 have air bags for both drivers and passengers. It's therefore impor-

tant to increase the number of motorists who buckle up and the number of infants and children traveling properly restrained.

The first thing to understand, as we try to accomplish these goals, is that information alone won't work. This has been proven again and again. For example, virtually everyone agrees that safety belts provide effective protection in crashes.[9] Yet despite almost universal knowledge, a sizable minority of motorists — 35 to 40 percent — still choose not to buckle up. Without belt laws, even fewer would buckle up. Among children 1-15 years old sitting in front seats, almost half aren't restrained at all, and many aren't restrained properly, even though this is a group at high risk of injury from inflating air bags. Restraint use improves when it comes to infants. Eighty-six percent of babies younger than 1 in front seats are restrained, based on a 1994 NHTSA survey.[10]

Now that virtually all new cars have passenger air bags, it becomes important for parents to learn to put infants in rear seats. Encouragingly, 74 percent of respondents to a 1995 Institute survey of 500 households nationwide said they know it isn't safe to travel with a baby in a rear-facing restraint in the front seat of a vehicle with a passenger air bag.[11] Seventy percent of this group believe it's a serious danger. These findings indicate that parents are hearing and understanding messages about the risks. Still, 23 percent of the parents surveyed reported they had placed a baby in a rear-facing restraint in the front of a car with a passenger bag.

Because we cannot rely on public information alone to reduce exposure to the risk of air bag injury, we need effective and well-targeted enforcement programs accompanied by appropriate publicity and information. Such programs should address both infant and child restraint

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[9]Newport, F.M. 1981. National safety belt study. Washington, D.C.: National Highway Traffic Safety Administration DTNH22-81-C-05224.

[10]National Highway Traffic Safety Administration. May 1, 1995. National occupant protection use survey: controlled intersection study. Research Note. Washington, D.C.: National Highway Traffic Safety Administration.

[11]Ferguson, S.A. and Williams, A.F. 1996. Survey of parents of infants about rear-facing child restraints. Arlington, VA: Insurance Institute for Highway Safety.

use as well as belt use among older children and adults. To accomplish the belt use part, we also need to strengthen safety belt laws in most states because the laws in only 10 states currently allow primary enforcement.[12] This is the case despite overwhelming evidence that primary laws produce higher use rates than the more prevalent secondary laws.

Insurers together with the Institute, NHTSA, the governor of North Carolina, and others have been conducting a statewide program for more than three years to demonstrate effective strategies to increase belt use and accomplish other highway safety objectives. This program has been such a success that North Carolina has become a model for the nation. We're presently developing and getting ready to add something else to the North Carolina initiative — a program targeted specifically at adults transporting infants and children. The objective is to greatly increase the number who travel properly restrained. This will be the first statewide enforcement and education program targeted at this problem, and we'll be inviting automakers to join with us in this effort. A number of auto insurers also expect to work with automakers and the U.S. Department of Transportation to find additional, effective ways to address this problem. Such initiatives take on special importance — over and above ensuring that all children travel restrained — when considered in the context of injury risk from inflating air bags.

Air bags are a major success. They're preventing many occupant deaths and serious injuries. And, as this statement indicates, there are ways we can reduce their unintended adverse side effects.

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[12]Under "primary" safety belt laws, police may stop vehicles solely for belt law violations. Such laws are in effect in California, Connecticut, Hawaii, Iowa, Louisiana, New Mexico, New York, North Carolina, Oregon, and Texas. Laws in other states and the District of Columbia are "secondary," meaning police must stop a vehicle for another violation before citing an occupant for failing to buckle up.

STATUS REPORT
INSURANCE INSTITUTE FOR HIGHWAY SAFETY
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Medical Successes Often Carry ADVERSE SIDE EFFECTS

Air Bags Are No Exception

As expected, air bags are saving lives. As expected, they're preventing injuries. They're hugely successful. But there's a downside, too.

Most successful medical and public health breakthroughs — air bags not excepted — cause some adverse side effects. Penicillin, for example, is part of our front-line approach to bacterial infections but provokes allergic reactions in some people, including rare fatal reactions. Polio vaccine has reduced cases of this disease from about 18,000 in the United States in 1954 to only a handful per year in the 1990s. Yet it has also caused paralytic polio in rare instances.

The most frequent side effects of air bags are bruises, abrasions, and other relatively minor injuries (see photo, p.2). But air bags infrequently cause serious and fatal injuries. These are the subject of a recent call for comments from the National Highway Traffic Safety Administration (NHTSA). Most comments address technological remedies for the problem of injuries induced by air bags.

Less Aggressive Inflators: One way to reduce some of these injuries is to use air bag inflators that have lower initial pressure onsets and/or lower overall pressure when a bag is fully inflated. But there's a possible tradeoff — air bags must inflate rapidly to protect people in severe crashes, but very fast inflation can mean injuries when people contact bags in the early stages of deployment. Such injuries might not have occurred without the air bag.

Most respondents to NHTSA agree that making air bag inflators less aggressive would reduce injury risk when people contact inflating bags. But in

RIDING WRONG

To keep a child from being positioned dangerously if a passenger bag deploys, put her in the vehicle's rear seat — in a special child restraint if possible or buckled with an adult safety belt.

What's Known About Air Bag Effectiveness, Hazards

Air bags have deployed in more than 650,000 crashes and reduced driver deaths in frontal crashes by about 20 percent. NHTSA estimates that about 1,000 lives have been saved since 1987. This is the success against which serious air bag injuries should be assessed. An Institute study of national data found that 96 percent of all injuries induced by air bags — injuries involving about 160,000 people — are minor ones like contusions or abrasions. Only about 1 percent are serious or fatal (see *Status Report*, Vol. 30, No. 3, March 18, 1995). Who's at greatest risk? Anyone in close proximity to a bag when it deploys. Especially vulnerable are drivers close to the steering wheel, infants in rear-facing safety seats, and unbelted or improperly belted people who move forward early in a crash or during braking just before impact. Recent deaths of some children are of particular concern. Children should ride belted in the back seat. If they have to travel in front, make sure they're in properly installed child restraints with the seat pushed back as far as possible or are using adult belts.

Two Items on Passenger Air Bags, see pp.6-7.

many cars, especially smaller ones, this solution could require regulatory action. Federal Motor Vehicle Safety Standard No. 208 requires air bags to inflate quickly to protect belted and unbelted test dummies in 30 mph barrier crashes. Automakers say they could use less aggressive inflators and design air bags that are optimal for people who use belts if NHTSA were to abolish the unbelted test.

Yet the intent of the federal safety standard is to provide *automatic* protection in frontal crashes, and the unbelted test is intended to ensure this for the many motorists who still don't buckle up. This is why there's considerable opposition to abolishing the unbelted test.

As an alternative, Ford is asking NHTSA to lower the speed in the unbelted test to 25 mph and, in return, to raise the test speed for belted dummies in passenger cars to 35 mph. The slower speed in the unbelted test would allow automakers to phase in reduced-output inflators starting about nine months alter the change.

BMW has another proposal that would permit reduced inflator energy. It favors amending the federal standard to increase the current maximum permissible chest gs of 60 in the unbelted test to 75 gs. Under this proposal, automakers would have to demonstrate a 25 percent reduction in inflator energy before using the higher chest g criterion.

Could less aggressive inflators also reduce protection to people in crashes at higher speeds? No, according to Institute analyses. Inflators that are less aggressive would actually enhance protection over a wide range of crash severities.

In-depth investigations of crashes from the National Accident Sampling System indicate that fatal injuries in air bag-equipped cars aren't happening because the bags fail to fully re-

strain the occupants. Instead, they're happening because of factors unrelated to restraint system performance — total failure of vehicle structure or multiple collisions, for example. Investigations of the National Accident Sampling System cases indicate that, if inflators were less aggressive, air bags could provide even more protection, especially to unbelted people. In several of the crashes of moderate severity, researchers found that the most serious injuries were caused by the bags, and in none of the other crashes did they find evidence that better air bag performance would have prevented the fatal injuries.

Based on this, the Institute strongly supports regulatory changes to allow less aggressive inflators. "NHTSA needs to take action," says Institute Vice President Susan A. Ferguson. "Changing the standard should result in inflators — especially those in smaller vehicles — that cause fewer serious air bag-induced injuries. And, far from reducing protection, there would be enhanced occupant protection in a broad range of crash severities."

Deployment Thresholds: Some serious injuries have occurred in relatively low-speed crashes in which occupant injuries would have been unlikely without the air bags. NHTSA therefore has requested information about the ease of increasing thresholds for air bag inflation to eliminate some deployments. Most automakers currently choose thresholds equivalent to a 10-12 mph barrier crash.

The Institute points to evidence that people without belts can be seriously injured at speeds just above these thresholds, indicating the thresholds should *not* be raised for unbelted occupants. But manufacturers can use a higher threshold for belted occupants without increasing the risk of injury. This would eliminate many unnecessary air bag deployments.

The Institute strongly supports the use of dual deployment thresholds, which already are being used by Mercedes and BMW. However, the Institute would oppose any proposal from NHTSA to mandate a minimum deployment threshold regardless of occupant belt use.

Infants and Children: The most serious concerns involve air bag injuries among infants and young children. These concerns won't be resolved by technological fixes in the short term.

NHTSA currently allows manufacturers to install manual cutoff switches for passenger bags in vehicles in which an infant restraint cannot be properly placed in the rear seat, and there are suggestions to allow such switches in all vehicles with passenger bags. The Institute opposes this because there's no reason to expect that adults who fail to understand warnings about infant restraints and air bags or who allow children to ride unrestrained would use such switches correctly.

The Institute urges NHTSA to work with automakers to develop standard specifications for automatic devices to address the problem of rear-facing infant restraints. For example, BMW has told the agency it plans to introduce in Germany late next year an automatic system that deactivates the passenger bag when it detects a rear-facing infant restraint.

Other Approaches: Most who submitted comments to NHTSA agree that the agency should continue to educate parents about the danger of placing infants and children in the front seats of vehicles with passenger bags and the importance of properly restraining children (see "Parents Know about Danger of Air Bags to Infants in Front Seats," p.6).

Longer-term solutions will result in "smart" air bags that determine occupant position, belt use, weight, and crash severity, and decide whether an air bag will deploy and when and how (see *Status Report*, Vol. 30, No. 3, March 18, 1995). Automakers are developing these but Ford, for example, says it anticipates about 10 years before advanced air bags are widely available.

Conference on Air Bag Injuries

Now that more information is becoming available on the air bag injury problem, various groups are addressing ways to alleviate it in the short and long term. Government representatives joined last month with automakers, air bag suppliers, and representatives from the highway safety and health care communities to focus on this task. Recognizing that using belts plus bags provides the most effective protection and that belts can keep people in positions where the hazards from inflating bags are reduced, conference participants recommended increasing belt use by encouraging and enforcing primary belt laws. They recommended a coordinated effort to spread information through both the media and health care professionals about effective crash protection and the extent of air bag injuries and how to reduce them — for example, by making sure children ride properly restrained in rear seats (see facing page).

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Fatalities in Air Bag-Equipped Cars: A Review of 1989-93 NASS Cases

Adrian K. Lund
Insurance Institute for Highway Safety

Susan A. Ferguson
Insurance Institute for Highway Safety

Michael R. Powell
Insurance Institute for Highway Safety

ABSTRACT

A review of 39 driver fatalities in 1990-93 cars with air bags from the National Accident Sampling System indicated most of these fatalities were due to causes unrelated to frontal air bag performance. Two-thirds occurred in side-impact or rollover crashes, in which air bag effectiveness is limited; of 15 frontal crash fatalities, 6 died of causes unrelated to the frontal impact and 5 in cars with severe intrusion. The remaining four fatalities, three of whom were unbelted, were in moderate to high severity crashes which could have been survivable; however the deploying air bags, instead of protecting, probably contributed to the fatal injuries. A similar review of 12 fatalities of unbelted drivers in cars without air bags revealed 3 could have been prevented by air bags, but 4 were in crashes that could have put them in position to be injured by the air bag. These results suggest that reducing deployment energy would improve air bag effectiveness in relatively severe crashes as well as low severity crashes, even for unbelted drivers. No examples of fatal driver injuries from air bags in low severity crashes were found.

INTRODUCTION

Air bags save lives and reduce injuries in frontal crashes for which they are designed. The National Highway Traffic Safety Administration (NHTSA) estimates that over 900 lives have been saved since 1987 [1]. Recent studies have estimated about 20 percent fewer driver fatalities than expected in frontal crashes for air bag-equipped cars than for cars equipped only with seat belts [2, 3, 4].

Air bags are designed primarily to protect vehicle occupants in frontal crashes. In crashes without significant frontal forces, such as side impacts and rollovers, they provide little or no protection. The automatic protection provided by air bags offers some benefit for both belted and unbelted occupants, but there are many serious crash situations in which unbelted occupants are ejected thus nullifying any protection from the air bags. Unbelted occupants may also be out of position when the air bag deploys because of precrash braking or precrash maneuvers, or because of multiple impacts, and as a result they may be outside the protective envelope of the air bag or too close to it for optimal protection. Some frontal crashes are unsurvivable even with seat belts and air bags because the extreme force of the crash may destroy the occupant compartment.

With about 50 million cars on the road equipped with driver air bags and an estimated 650,000 deployments by the end of 1995, it has become evident that air bags also can cause injuries. The overwhelming majority of these injuries are minor abrasions and contusions, but about 1 percent are serious [5]. A small number of cases have been documented in which adult drivers, as well as infants and young children in the right front passenger seat, have died as a result of air bag-related injuries to the head and chest [6]. These fatalities are troubling because they occurred in low to moderate severity crashes in which it is likely that no injuries or only minor injuries might otherwise have occurred.

To protect occupants in frontal crashes, air bags must deploy in less than one 20th of a second, and the energy of the deploying air bag itself can result in serious injuries if an occupant is close to it at the time of deployment. Drivers who sit close to the steering wheel, particularly shorter, often elderly women, and unbelted or improperly belted drivers and passengers appear to be most at risk. Unbelted occupants can continue moving forward when the vehicle is slowing as a result of precrash braking or multiple impacts; as a result they may be very close to the steering wheel or instrument panel at the beginning of the air bag deployment.

An important question is how future air bag designs might be improved to reduce air bag induced injuries — both minor as well as serious injuries. Because air bag induced injuries are caused by the energy of the inflating bag, one obvious possibility is to reduce this energy. However, in so doing, the air bag may lose some of its capacity to protect occupants in more severe crashes, especially unbelted occupants.

This study examines the mechanisms by which drivers are fatally injured in air bag-equipped vehicles. A detailed review of fatal driver crashes in recent-model, air bag-equipped vehicles was undertaken to determine whether there is any evidence that air bags fail to protect drivers in frontal crashes, either because the air bag had insufficient energy to adequately restrain the driver's forward movement or because the air bag contributed to injury. The review used cases from the National

Accident Sampling System (NASS) [7]. For purposes of comparison, a similar review of frontal crashes of cars without air bags, in which an unbelted driver was killed was also undertaken. These cases were reviewed to determine what effect a driver air bag could have had on the outcome of the crash.

METHOD

CASE SELECTION — NASS contains detailed investigations of a sample of all towaway crashes in the United States. Information, both written descriptions and photographs, is provided on crash circumstances, including precrash maneuvers and scene information, such as other vehicles impacted and objects impacted. Vehicles are examined in depth to provide information on vehicle deformation, including exterior and interior damage, possible occupant contacts, air bag deployment, and belt use. Also provided, to the extent that it is available, is detailed information on occupant injury and possible sources of these injuries.

For this study all crashes in NASS 1989-1993 that involved a driver fatality in a recent model passenger vehicle (1990 model year or newer) equipped with at least a driver air bag were included. In addition, frontal crashes (defined as crashes where the principal direction of force was between 10 and 2 o'clock) were identified from NASS 1989-1993 with a known delta V involving 1990 or newer model year passenger vehicles not equipped with air bags in which an unrestrained driver was killed. Thirty-nine air bag cases and 12 non-air bag cases meeting these criteria were found.

REVIEW PROCESS — All of the data files were reviewed in detail and each qualifying case was classified according to the following variables.

Principal Crash Event — Each crash was classified according to whether the principal damage occurred in a *frontal*, *side*, or *rollover* event. The principal event was determined by examining either the deformation location variable for frontal and side impacts, or the type of damage variable for rollovers, in the Collision Deformation Classification (CDC) code assigned by the NASS investigator to the most severe crash event experienced by the subject vehicle. There were no driver fatalities in the NASS database in air bag-equipped cars where the principal event was a rear-end crash. Two cases where the most severe event was an impact to the top of the vehicle, in which the top impact was made possible by a prior rollover event, were classified as rollover crashes.

Number of Impacts — The number of crash events experienced by each vehicle was classified as either single or multiple. Multiple-event crashes were defined as those in which the vehicle experienced at least one other significant crash event in addition to the principal one. Crash events included events such as rollovers as well as impacts, so that, for example, a severe side impact crash followed by a quarter-turn rollover was classified as a multiple-event crash.

Cause of Death — The NASS case reports include an indication of the most likely cause of the drivers' fatal injuries. For this paper, the fatal injuries were classified into one of five categories: *intruding vehicle surface*, *nonintruding vehicle surface*, *ejection*, *air bag*, *or non-impact causes*. Contact with an *intruding vehicle surface* encompasses cases in which the driver died as a result of contact with a vehicle surface that intruded into the subject vehicle occupant compartment during the crash. This category included several cases in which the destruction of the occupant compartment was so massive as to make the driver's survival unlikely. Contact with a *nonintruding surface* encompasses cases in which the driver died from contact with a vehicle surface, such as an A pillar, that was not intruding into the occupant compartment.

Ejection included cases in which a complete or partial ejection of the driver from the vehicle, according to the NASS investigator, led to the fatality. This category included cases in which the driver contacted objects outside the vehicle and cases in which crushing injuries were sustained as a result of the driver being trapped under the vehicle during a rollover.

Cases in which the air bag may actually have contributed to the driver's death were classified as *air bag-related*.

In some cases, drivers died of causes not directly related to the crash. These cases were classified as *non-impact*. This category includes cases in which drivers were thought to have died due to drowning (which occurred after the main crash events caused the vehicle to enter a body of water), fatal burns sustained in postcrash fires, and natural causes.

The investigations conducted for this study concurred with the NASS indication of cause of death with one exception: An injury attributed by NASS to impact with the steering wheel was redesignated to the *air bag-related* category. In addition, in one crash there was too little information to classify cause of death in these categories. Essentially similar reviews were conducted of the frontal crashes of cars without air bags.

RESULTS

FATALITIES IN AIR BAG-EQUIPPED CARS — Table 1 summarizes the crash information for the 39 driver fatalities in air bag-equipped cars. About half of the fatalities (18) occurred in single-event crashes and the other half (21) involved multiple events. Forty-four percent of the fatally injured drivers were belted, 46 percent were unbelted, and belt use was unknown in 10 percent of the cases. More than half of the fatalities occurred in crashes in which the principal event was a side impact (46 percent) or rollover (15 percent); only 38 percent occurred in crashes in which the principal event was frontal (Figure 1).

As shown in Figure 2, the air bags deployed in every case in which the principal event was a frontal impact (with the possible exception of one case where deployment status was unknown) and in about 55 percent of the cases in which it was a side impact or rollover. Although air bags typically are not intended to deploy in nonfrontal crashes, most of the side impact deployment crashes in this analysis either had secondary frontal impacts that may have deployed the air bag or the side impact had a longitudinal velocity change component sufficient to trigger the deployment. In one of the rollover crashes, a secondary frontal impact may have deployed the air bag. The other two rollover deployments involved severe roof impacts that may have had large longitudinal velocity change components (although the velocity change was not calculated for the roof impacts).

Table 1. Summary of 39 Driver Fatalities in Air Bag Equipped Cars 1990 or Newer Models in 1989-1993 NASS

Case ID	Principal Crash Event	Number of Events	Belt Use	Cause of death	Velocity Change (mi/h)	Air Bag Deployment
05-125A 1993	Frontal	Single	Belted	Air bag	29	Yes
82-057A 1991	Frontal	Single	Belted	Vehicle intrusion	59	Yes
11-112A 1993	Frontal	Single	Belted	Vehicle intrusion	Unknown	Yes
79-021A 1991	Frontal	Single	Unbelted	Air bag	46	Yes
06-006A 1993	Frontal	Single	Unbelted	Air bag	29	Yes
08-021A 1993	Frontal	Single	Unbelted	Non-impact	16	Yes
75-023A 1991	Frontal	Single	Unbelted	Vehicle intrusion	39	Yes
49-243C 1993	Frontal	Multiple	Unknown	Non-impact	Unknown	Yes
11-128A 1993	Frontal	Multiple	Belted	Non-impact	15	Yes
11-111A 1990	Frontal	Multiple	Belted	Vehicle intrusion	Unknown	Yes
08-133A 1993	Frontal	Multiple	Unbelted	Air bag	Unknown	Yes
48-122A 1992	Frontal	Multiple	Unbelted	Ejection	13	Yes
43-210A 1992	Frontal	Multiple	Unbelted	Ejection	36	Yes
79-139A 1991	Frontal	Multiple	Unbelted	Vehicle intrusion	30	Yes
49-129A 1992	Frontal	Multiple	Unknown	Non-impact	Unknown	Unknown
81-199A 1991	Rollover	Single	Unbelted	Ejection	Unknown	Unknown
43-077A 1991	Rollover	Multiple	Belted	Non-impact	Unknown	Yes
09-501A 1992	Rollover	Multiple	Belted	Vehicle intrusion	Unknown	Yes
06-091J 1992	Rollover	Multiple	Unbelted	Ejection	Unknown	Yes
11-128A 1992	Rollover	Multiple	Unbelted	Ejection	Unknown	No
41-142A 1990	Rollover	Multiple	Unbelted	Non-impact	Unknown	No
09-066A 1990	Side	Single	Belted	Ejection	30	Yes
43-109A 1992	Side	Single	Belted	Ejection	33	Yes
09-505A 1992	Side	Single	Belted	Vehicle intrusion	35	Yes
73-199A 1992	Side	Single	Belted	Vehicle intrusion	Unknown	Yes
81-038K 1993	Side	Single	Belted	Vehicle intrusion	18	No
48-211J 1993	Side	Single	Belted	Vehicle intrusion	25	No
09-506A 1992	Side	Single	Unbelted	Ejection	Unknown	No
09-142A 1993	Side	Single	Unbelted	Unknown	27	Yes
05-193A 1991	Side	Single	Unbelted	Vehicle intrusion	Unknown	No
73-013C 1992	Side	Multiple	Unknown	Vehicle intrusion	18	No
06-058A 1993	Side	Single	Unknown	Non-impact	Unknown	Unknown
11-145A 1991	Side	Multiple	Belted	Ejection	Unknown	Yes
06-030A 1992	Side	Multiple	Belted	Non-impact	Unknown	No
48-092A 1992	Side	Multiple	Belted	Vehicle intrusion	18	No
09-184A 1990	Side	Multiple	Belted	Vehicle intrusion	25	Yes
49-157A 1992	Side	Multiple	Unbelted	Ejection	Unknown	Yes
73-123J 1993	Side	Multiple	Unbelted	Ejection	Unknown	No
41-501A 1992	Side	Multiple	Unbelted	Non-intruding surface	Unknown	Yes

Figure 1. Driver Fatalities in Air Bag Equipped Cars by Principal Crash Event. (n = 39)

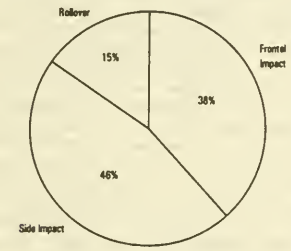
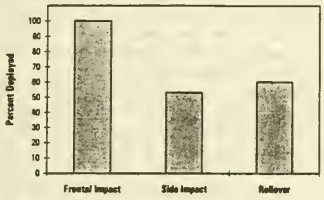


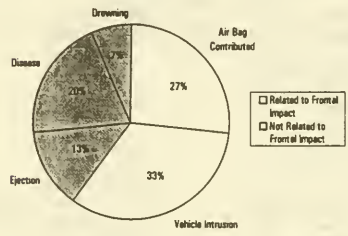
Figure 2. Air Bag Deployment in Fatal Crashes of Air Bag Equipped Cars by Principal Crash Event (Excludes Three Cases of Unknown Deployment).



Among the 24 nonfrontal fatal crashes, there were no cases in which an air bag could have provided benefit to the driver, but did not deploy. Nor were there any cases among the nonfrontal crashes where air bags appeared to have contributed to the fatal injuries. In nine of these cases, the fatal injuries were caused by contact with intruding vehicle structure and in one case with non-intruding vehicle structure. In another nine, the fatal injuries occurred during either partial or total ejection; six of these drivers were unbelted and three were fully ejected. The three belted drivers died as a result of partial ejection. Among the other five nonfrontal fatal crashes, the cause of death was unknown for one and was unrelated to the impact events for four others (one drowned, two were burned in vehicle fires, and one died of cardiac arrest).

Frontal Crashes — Fifteen of the driver fatalities in air bag-equipped cars occurred in crashes where the principal event was a frontal impact. However, in more than one-third (six) of these fatalities, the fatal injuries did not occur in the frontal impact portion of the crash (Figure 3). Two were the result of injuries suffered after the driver was ejected from the

Figure 3. Cause of Fatal Injury to Drivers in Crashes of Air Bag Equipped Cars Where Principal Event was Frontal Impact. (N=15)



vehicle; both of these vehicles rolled over after the initial frontal impact, and both ejected drivers were unbelted. Two of the remaining four drivers died of cardiac illness prior to the crash events, one died of unspecified medical complications in the hospital, and the sixth driver drowned when his vehicle traveled over the side of a bridge after the initial frontal impact. Air bag performance in these six fatal cases was essentially as expected and unrelated to the fatal outcome.

The other two-thirds of the drivers (nine) in frontal impacts died from injuries sustained during the frontal impact portion of the crash, caused either by vehicle intrusion (five cases) or the deploying air bag (four cases).

Drivers were belted in three of the five cases in which the cause of death involved vehicle intrusion (Table 2). All three of these crashes were extremely severe and were considered unsurvivable; two involved head-on impacts with tractor-trailer combinations.

One of the two unbelted, intrusion-related fatalities also involved massive occupant compartment deformation and was considered unsurvivable. The other unbelted, intrusion-related fatality occurred in a crash with less occupant compartment deformation, but the impact with a pole at the center of the car resulted in severe rearward movement of the steering wheel, and the rim was in an almost horizontal plane after the crash. It seems likely that the edge of the steering wheel rim was the source of the fatal injury, which was a transected aorta (AIS 6). It is unclear why the steering wheel intrusion was so great. One possibility is that the steering column broke under the load of the 195 pound, unbelted occupant, allowing the rim to dig into the chest as the column rotated upward. There was also a subdural hematoma (AIS 4) that might have occurred as the body followed the rotation of the wheel with the air bag, allowing the head to impact the upper interior of the vehicle or the windshield (where there was evidence of impact). It is also possible that the air bag contributed to the driver's injuries, if the pole crash resulted in a late deployment that allowed the driver to contact the steering wheel before air bag deployment. The severe chest injuries would then be attributable to the deployment force of the bag, with the head injury still presumed to occur after the steering column began to rotate or break. However, the car in this crash (a 1992 Ford Tempo)

Table 2. Driver Fatalities in Air Bag-Equipped Cars By Cause of Death and Belt Use

Cause of Death	Belt Use			
	Yes	No	Un-known	Total
Frontal Crashes				
Air bag	1	3	0	4
Vehicle intrusion	3	2	0	5
Ejection	0	2	0	2
Non-impact	1	1	2	4
Total	5	8	2	15
Nonfrontal Crashes				
Air bag	0	0	0	0
Vehicle intrusion	7	1	1	9
Non-intruding surface	0	1	0	1
Ejection	3	6	0	9
Non-impact	2	1	1	4
Unknown	0	1	0	1
Total	12	10	2	24

had several crash sensors, one of which is located in the center of the front of the vehicle where the pole impact should have signaled a deployment early in the crash. Thus, late deployment, though possible, seems unlikely.

Air bags contributed to drivers' fatal injuries in four frontal crashes. As these cases directly address the issue of air bag energy, they are described in some detail. Only one of these drivers was belted, according to the NASS investigation (Case 05-125A 1993). In this case, a 1992 Toyota Camry ran off the right side of the road and struck a utility pole. Occupant compartment deformation was only moderate, and the delta V (29 mi/h) indicates this was a survivable crash for a belted driver even without an air bag. However, the driver, a 62 year old female, 5 feet 2 inches tall and weighing 179 pounds, suffered a bilateral flail chest (AIS 5) and a perforated right ventricle laceration (AIS 5). These injuries are consistent with those expected for a driver against or very near the steering wheel during air bag deployment. This position seems probable, given the driver's short stature, which likely means a forward seating position, and, because pole impacts delay deployment in some cases, the air bag may have deployed relatively late in the crash, allowing the driver's upper body to rotate even closer to the steering wheel.

The other three cases in which the driver fatality was attributed to the air bag involved unbelted drivers. In all three cases, the driver was reported by the NASS investigator to have suffered incapacitating illness prior to the crash, although it is unclear how this determination was made. These and other factors make it unlikely that these drivers were in position to be protected by the air bag in the crash, and their injuries are consistent with having been struck by the air bag or air bag deployment doors early in the deployment phase.

In one case, a 1991 Dodge Caravan struck the rear end of a parked 1958 Chevrolet Bel Air (Case 79-021A 1991). The Caravan's driver was a 35 year old male, 5 feet 6 inches tall and weighing 160 pounds. His fatal injuries were a full thickness laceration of the right ventricle with hemopericardium (AIS 5) and a contusion of the interventricular septum (AIS 4). Although these injuries were attributed to the steering wheel by the NASS investigator, they are consistent with loading from a deploying air bag, and there was no steering wheel rim deformation, which would be expected had such severe injuries been caused by the steering wheel. There was no rearward movement of the steering wheel/column. In addition, the nature of the crash suggests the unbelted, possibly incapacitated driver (who also had a BAC of 0.16 g/dl) would have been near the air bag when it deployed. Although the delta V was estimated to have been 46 mi/h and the maximum crush to the front of the Dodge Caravan was only 11 inches, the soft rear-end structure of the Chevrolet Bel Air crushed 50 inches and probably provided a very long-duration, small-magnitude deceleration, which might not have deployed the air bag until late in the crash.

In the second unbelted case, a 1990 Plymouth Aclaim ran off the road and struck a tree (Case 06-006A 1993). Delta V was estimated at 29 mi/h. The driver, an unbelted 64 year old male, 5 feet 7 inches tall and weighing 160 pounds, suffered fatal injuries consisting of lacerations to the right atrium (AIS 6) laceration of the superior vena cava (AIS 3) and multiple bilateral rib fractures (AIS 4). These injuries are consistent with loading from a deploying air bag; the lack of belt use and possible incapacitation make it possible that he was near the steering wheel when the bag deployed. Occupant compartment deformation was only moderate, and there were no other contact points consistent with the fatal injuries.

In the third unbelted case, a 1992 Chrysler New Yorker Fifth Avenue ran off the left side of the road, broke through a row of shrubbery, and continued down a sloped yard until it struck and uprooted a small tree (Case 08-133A 1993). The driver was an unbelted 58 year old male, 6 feet tall and weighing 187 pounds. Again, he suffered fatal injuries consistent with loading during the early phase of air bag deployment: bilateral rib fractures with hemothorax (AIS 5), a heart laceration (AIS 3), and a pericardium laceration (AIS 2). Because of the multiple frontal impacts, delta V was not calculated for this crash. The current investigators concluded that the air bag probably deployed in the second, more severe collision with the tree. The initial collision with the shrubbery could also have exacerbated the poor position of the unbelted, possibly incapacitated driver. The air bag deployment may have been further delayed during what was probably a relatively soft, long crash pulse during impact with the tree. It is also possible, though, that the air bag deployed during the initial frontal impact with the shrubbery and that the fatal injuries occurred from contact with the steering wheel in the more severe tree impact when the air bag was no longer available for protection. Deformation of the steering wheel rim was consistent with this possibility.

FATAL FRONTAL CRASHES OF UNRESTRAINED DRIVERS WITHOUT AIR BAGS — The NASS cases in which unrestrained drivers died in frontal crashes of vehicles not equipped with air bags are summarized in Table 3. In four of these cases, drivers died of causes not related to the main frontal impact, and the potential benefit of air bags would have been limited. One driver died of cardiac disease, and three

Table 3. Summary of 12 Unrestrained Driver Fatalities in Frontal Crashes of Cars Without Air Bags 1990 or Newer Models in 1989-1993 NASS

Case Number	Frontal Impact With	Additional Events	Most Severe Injury Region/Source	Delta-V mi/h
79-157A 1993	Pole	None	Disease/Heart	21
79-187A 1992	Jersey wall	Subsequent roll	Head/Ejection	15
11-092A 1992	Guardrail	Subsequent roll	Head/Ejection	13
11-018A 1992	Tree	Subsequent roll	Head/Ejection	40
11-081J 1993	Car	None	Head/Multiple, unsurvivable	34
43-128A 1992	Car	None	Chest/Steering wheel	29
06-040A 1993	Pole	None	Chest/Steering wheel	37
72-190A 1990	Car	None	Chest/Steering wheel	36
73-193A 1992	Culvert	Prior ditch, subsequent roll	Chest/Steering wheel	24
06-135A 1992	Tree	Prior fence, postcrash fire	Chest/Steering wheel	24
02-158A 1991	Tree	Prior sideswipe	Chest/Instrument panel	55
01-120A 1990	Car	Subsequent roll, roof impact with another car	Head/Roof Chest/Steering wheel	47

drivers were ejected in rollover events following the frontal impact. In all three of the ejections, the unbelted drivers were partially ejected through the driver side door window and suffered massive head injuries as their heads were trapped between the vehicle and the ground. Two of these ejections occurred after very low speed frontal impacts (velocity changes of 13 and 15 mi/h).

In the other eight crashes, the driver fatalities were the result of contact with interior vehicle surfaces, particularly the steering wheel and instrument panel. One of these involved a 1990 Ford Probe in a very severe passenger-side corner impact with a large Ford pickup; this crash could have been classified as a side impact, although there was clearly a large frontal component (Case 11-081J 1993). This crash was essentially unsurvivable, with fatal head injuries from contact with the center and right side instrument panel, steering wheel, and perhaps even the pickup, as the occupant compartment was severely deformed. The significant lateral forces and intrusion make it unlikely that an air bag could have prevented these or other potentially fatal injuries in the absence of belt use.

Three of these fatalities suffered injuries that should have been mitigated by an air bag, had it been present (Cases 43-128A 1992, 72-190A 1990, 01-120A 1990). They were car-to-car, head-on collisions in which fatal chest injuries came from severe loading of the steering wheel; these were classic examples of the frontal crash event simulated by the flat barrier tests in which air bag designs are evaluated. One of these crashes, however, was a multiple event in which the car also rolled over and was struck in the roof by a third vehicle; even with air bags, this driver would still have died of a fatal head injury that occurred during this final impact.

The other four fatally injured, unbelted drivers might also have benefited from air bags in their frontal impacts, but all four had characteristics similar to cases in which air bags were believed to have contributed to fatal injury. Three involved other events prior to the principal frontal impact that would almost certainly have placed the driver out of position for optimal air bag performance and could have placed him or her in danger from the air bag itself. In one of these cases, a 1990 Eagle Talon struck a culvert after going into a ditch (Case 73-193A 1992); in the second case, the driver of a 1992 Buick Regal, with a blood alcohol concentration of 0.19 g/dL, broke through a chain link fence and traveled through a field before striking a tree head on with an estimated delta V of 24 mi/h (Case 06-135A 1992); and the driver of a 1990 Dodge Caravan, also with a high BAC, left the road, entered a wooded area, and sideswiped a small tree before striking a larger tree with a delta V of 55 mi/h (Case 02-158A 1991).

The fourth case involved a high speed pole impact (delta V of 37 mi/h). Because pole hits can result in late air bag deployment in some cases, there again is the possibility of the driver being too near the air bag at the time of deployment. Thus, in each of these last four cases, an air bag might have mitigated some of the fatal injuries but that potential would be greater if deployment energy were reduced.

DISCUSSION

In the cases reviewed in this study, the vehicle's crashworthiness designs, including air bags, did not prevent the deaths of drivers. It is important to remember that the life saving effects of air bags have already been well-documented, at least for drivers [2, 4, 8]. By looking at these cases, this study can lead to ways in which the successful occupant protection provided by air bags might be improved.

The majority of driver fatalities in air bag-equipped cars in NASS cases occurred in crashes where the principal crash event was nonfrontal. In addition, of the fatalities in crashes that were principally frontal, one-third were not attributable to injuries incurred in the frontal impact portion of the complete crash event. Altogether, only 9 of 39 driver fatalities occurred in situations where air bags might have been expected to prevent the fatality. It is also noteworthy that four of these fatalities occurred in crashes with such severe occupant

compartment deformation that survival was highly unlikely, and a fifth occurred as the result of severe rearward movement of the steering wheel.

Thus, there were four driver fatalities where air bags clearly did not provide the protection expected of them. All four drivers, one of whom was belted, suffered fatal chest injuries consistent with loading from the air bag during the early phase of deployment. In each case, the crash circumstances suggest that the driver's chest would have been against or very near the steering wheel hub at the time of deployment.

All four of these were moderately high severity crashes, in which the drivers might have suffered fatal injuries in the absence of an air bag. These cases stand in contrast to the air bag induced fatalities in low severity crashes that have been investigated by NHTSA, in which it is likely occupants would have survived with only minor injury had the air bag not deployed. This observation suggests that air bags with less energy might reduce the likelihood of serious injury in moderately severe crashes as well as in the low severity crashes. The fact that three of the four drivers who might have benefited were unbelted is of particular interest because of concerns that less energy in air bags might reduce the protection offered to unbelted occupants.

In none of the cases reported here does it appear that unbelted drivers were fatally injured because their air bags deployed too slowly or with too little energy. Rather, they were out of position when the air bag deployed and the energy was too great to tolerate. This review of NASS air bag cases suggests that unbelted drivers will benefit from a reduction in air bag energy even in moderate to high speed crashes, because they are often not in position to benefit from the additional ride-down that a high energy deploying air bag would provide; rather, the high energy air bag may become an additional source of severe injury.

This conclusion is strengthened by the review of unbelted driver fatalities in frontal crashes without air bags. Several of these drivers had pre-impact events that made it very likely that they would have been out of position when the frontal impact would have deployed a hypothetical air bag. Had they still been behind the steering wheel, they might well have been so close as to be injured by the bag deployment itself. Thus, drivers for whom there has been concern that lower energy air bags would reduce protection in higher severity crashes may actually benefit from that change.

It is also notable that all four of the drivers who sustained fatal injuries attributable to the air bag did so in crashes in which the air bag deployment might have been relatively late in a soft crash pulse. Three were pole-type crashes, and serious pole impacts can be difficult for sensors to distinguish from low severity nondeployment situations; the fourth involved a very long duration crash into the soft rear of another car. A longer time to deployment can allow the driver, particularly if unbelted, to move closer to the air bag. One or more of these fatalities might have been prevented by sensors that discriminated these crash circumstances earlier. However, it would not be acceptable to simply set sensors at a lower threshold, as that could increase the number of air bag deployments in the much more numerous low severity crashes, with accompanying increases in air bag-induced injury in those crashes.

It may be that this is an area for the application of intelligent vehicle technology being developed for advanced collision warning. Research is needed to determine if this technology might be adaptable to provide earlier signals for air bag deployment, perhaps even before the collision. Such predictive warning could permit air bag deployment to begin sooner in all types of crashes. With the use of anticipatory sensors, air bags could inflate more slowly and still be in position in time to restrain occupants very early in the crash. Although anticipatory sensing could result in more unintended deployments, these would be at lower energy and less likely to cause injury.

Finally, it is important to note that 2 of the 15 drivers who died in frontal crashes with air bags were unbelted and incurred their fatal injuries when ejected. A third driver struck a steering wheel rim that moved rearward substantially only because he also was unbelted. Furthermore, the three unbelted drivers whose fatal injuries were caused by the air bag might have benefited from seat belt use, although the fact that each of those drivers may have been incapacitated prior to the crash makes that prediction uncertain. The quickest way to increase the effectiveness of air bags would be for drivers to wear the available lap and shoulder belts correctly and position themselves as far back from the steering wheel as they can and still drive comfortably.

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The CHAIRMAN. Thank you very much.

I will now call on Mr. Parker, and Senator Bryan has a time problem, so at any point I want you to interrupt with your questions if we get toward the 11 o'clock time.

STATEMENT OF MR. GEORGE PARKER, VICE PRESIDENT, ENGINEERING AFFAIRS, ASSOCIATION OF INTERNATIONAL AUTOMOBILE MANUFACTURERS, 1001 19TH STREET, N., SUITE 1200, ARLINGTON, VA 22209

Mr. PARKER. Thank you very much. Good morning, Mr. Chairman AND SENATOR BRYAN. I also would like to summarize my statement and have the full statement submitted for the record.

I am George Parker, vice president for Engineering Affairs of the Association of International Automobile Manufacturers. AIAM is a trade association representing companies that sell passenger cars, and light trucks in the United States that are manufactured both here and abroad.

Just for your reference, before I joined AIAM I was associate administrator for research and development at the National Highway Traffic Safety Administration, responsible for many research activities involving airbags, including monitoring their field performance.

We appreciate the opportunity to appear before you today. We believe that if the recommendations we make are implemented by the National Highway Traffic Safety Administration, occupant protection will be improved and airbags can be even more effective in saving lives and preventing injuries.

AIAM member companies are fully committed to airbags, which we believe are a very important and effective advancement in occupant protection. Some of our members have provided airbags as standard or optional equipment beginning in the mid-1980's, even before passive occupant protection was required by law.

Even though airbags are very popular with the public, it must be remembered that safety belts are the primary occupant protection system in vehicles. They are more effective in reducing the chance of fatalities in serious crashes, and they help provide protection in all crash modes, whereas airbags provide crash protection only in frontal crashes. Thus, as a general matter, we believe the public policy focus should be on increasing safety belt use and educating the public that airbags are for supplemental protection.

Field evaluations of airbag performance reveal that airbags are saving lives and reducing injuries, especially serious injuries. However, like many other public health actions such as vaccines and even safety belts, the widespread adoption of airbags has resulted in a small increase in the risk of minor injury, such as arm and facial abrasions and forearm fractures, and it has caused serious injury and death in certain unusual and rare circumstances.

There have been 27 fatalities attributed to airbag deployment; 12 of these have been driver fatalities and 15 have involved children, including 4 in rear-facing child restraints. All of the passenger side child fatalities occurred because the child was not restrained, or was improperly restrained. Also, some of the driver fatalities occurred because the driver was unrestrained or improperly restrained.

What is needed are primary safety belt use laws in all States and increased enforcement of those laws. In addition, a public education campaign is needed to alert the public to the importance of wearing safety belts and wearing them correctly, and to the dangers of placing infants in rear-facing child restraints in passenger seats with airbags.

Safety belt use is about 67 percent overall.

Jurisdictions that have implemented primary laws, and have enforced these laws, have seen an increase in belt use above this level. In studying these activities, NHTSA has found that primary safety belt use laws, aggressive enforcement of those laws, and public information announcements about the law and the enforcement program, are the most effective means of raising the level of safety belt use.

We have urged NHTSA to formulate a coalition of stakeholders to generate public support for and to secure primary safety belt use laws and increased enforcement of such laws, and to conduct a safety belt public education campaign. The member companies of AIAM are ready to support and take part in this effort.

When passive occupant protection became a priority for NHTSA and the safety advocates, it was primarily because safety belt use was so low, and the prospects of increasing usage to a high level so remote. The greater effectiveness of safety belts in protecting occupants in all crash modes, plus the high and growing level of safety belt use, mean that airbags should now be promoted as effective supplemental occupant protection.

The holdover from the passive protection character of FMVSS–208 is a requirement in the standard to meet certain injury criteria in the 30-mile-per-hour frontal impact into a rigid barrier using an unbelted dummy.

The need to meet the injury criteria with an unbelted dummy requires aggressive airbag deployment. It is this aggressive airbag deployment that causes the risk of minor and serious injuries and fatalities to out-of-position occupants that are in close proximity to the airbag at the time of deployment.

AIAM member companies have conducted substantial research and adopted various features in their airbag systems to try to minimize the effects of aggressive airbag deployment in producing minor and serious injuries and fatalities, and we expect to continue this effort vigorously.

However, at this time, it is not clear that the effects of aggressive airbag deployment made necessary by the unbelted dummy tests in FMVSS–208 can be fully overcome. It is now time to reconsider the passive protection requirements of FMVSS–208.

In response to a November 9, 1995 notice for comments,

NHTSA has been presented with a number of recommendations to reduce airbag aggressivity. All would change the nature of the FMVSS–208 requirements as it relates to passive protection. We strongly believe that NHTSA should establish a partnership with the industry to further develop and choose the best way for changing FMVSS–208.

Relating this to Dr. Martinez' concern, this partnership would evaluate the various options and ensure that, if any changes to the

standard are made, there would be an overall safety benefit to the public.

NHTSA can bring to the partnership a public policy perspective and its expertise. The industry can bring to the partnership its knowledge of the variety of airbag designs being used by different manufacturers, its vast test capability, and its commitment to continue advancing airbag designs in promoting airbags.

The partnership can make decisions based on science, as Dr. MARTINEZ INDICATED. We believe the partnership approach aligns with the desires of the current administration and the Congress for a less confrontational, more common sense approach to regulation. We believe both NHTSA and the auto industry are equally motivated to solve this problem, and the member companies of AIAM are ready to help.

In the longer term, while advanced technology for smart airbag systems may solve most of the rare airbag deployment problems, and may allow airbags to become more effective, this technology is only now being developed and its application unknown. Such smart airbag systems could sense seat occupancy, safety belt use, and other parameters, and then tailor airbag deployment decisions and airbag deployment characteristics to minimize airbag injuries and maximize airbag occupant protection.

Some commentors to NHTSA's November 9, 1995 notice for comment have implied that this technology is nearly ready to go. However, auto manufacturers have indicated that smart airbag systems cannot be implemented for a few years.

This apparent inconsistency has to do with the incorporation of technology into the vehicle. The suitability and reliability of current technology has not been demonstrated. Further, incorporation of this technology into vehicle designs will require substantial design efforts, including extensive testing, before smart systems could be implemented and offered to consumers.

AIAM member companies are conducting research and development programs on smart systems and expect to introduce them in the coming years. One near-term application of smart technology has the potential to solve some of the problem of rear-facing child restraints being used in passenger seating positions with airbags. Two AIAM member companies expect to introduce systems that recognize tags on specifically designed child restraints and turn off the airbag.

In summary, I want to thank you for the opportunity to present our views. To reiterate our recommendations and commitments: NHTSA should form and lead a coalition to secure primary safety belt use laws and increased enforcement of such laws, and to conduct a safety belt publication campaign. We are ready to support such an effort. NHTSA should form a partnership with the industry to devise a way to revise FMVSS–208 to reduce the consequences of the unbelted dummy test. We are ready to support this effort.

AIAM member companies are committed to continuing research and development programs on smart airbag systems.

Auto manufacturers are providing airbags in response to market demand and their occupant protection benefits. However, airbag design is dictated in large part by Federal regulation.

Auto makers have taken extraordinary steps to minimize the rare risks of injury or fatality resulting from that regulation. We believe that manufacturers should not be subjected to product liability risks when they are responding in good faith to a Federal mandate. We urge Congress to address this exposure and to provide a safe harbor for manufacturers who have acted responsibly. Thank you.

[The prepared statement of Mr. Parker follows:]

STATEMENT OF MR. PARKER

Good morning, I am George Parker, Vice President for Engineering Affairs of the Association of International Automobile Manufacturers, Inc. (AIAM). Before joining AIAM, I was a 27-year employee of the National Highway Traffic Safety Administration (NHTSA). From 1990 until I left NHTSA in 1995, I was Associate Administrator for Research and Development responsible for many research activities involving air bags, including monitoring their performance in the field. AIAM is a trade association that represents companies which sell passenger cars and light trucks in the United States that are manufactured both here and abroad.[1]

We appreciate the opportunity to appear before you today to address the field performance of air bags, possible revisions to Federal Motor Vehicle Safety Standard (FMVSS) 208, and other issues regarding air bags and safety belts. We believe that, if the recommendations we make today are implemented by the National Highway Traffic Safety Administration, occupant protection will be improved and air bags can be even more effective in saving lives and preventing injuries.

Commitment to Air Bags

AIAM member companies are fully committed to air bags, which we believe are a very important advancement in occupant protection. Some of our members have provided air bags as standard or optional equipment beginning in the mid-1980s, even before passive occupant protection was required by law. The public, as we now know, appears to endorse air bags, and our members have responded by offering both driver and passenger side air bags. Congress has now required that new passenger vehicles offered for sale have driver and passenger side air bags after September 1, 1997, for passenger cars and September 1, 1998, for other passenger vehicles. Our members have responded to that mandate and will provide driver and passenger side air bags substantially before the mandate for almost all vehicles they sell.

Even though air bags are very popular with the public, it must be remembered that the primary occupant protection system in vehicles is safety belts. Lap/shoulder safety belts can reduce the chance of fatalities in serious crashes by 45 percent, and air bags in conjunction with safety belts reduce the chance of fatalities in serious crashes by another 5 percent. Other serious crashes are too severe for any restraint system to protect occupants from fatal injuries. Frontal air bags by themselves reduce the chance of fatalities in serious crashes by about 10 percent. Air bags are most effective in frontal crashes where they reduce the chance of fatalities by 28 percent to 35 percent on average when combined with some belt use. Safety belts help to provide protection in all crash modes whereas air bags provide protection only in frontal crashes. Thus, as a general matter, we believe the public policy focus should be on increasing safety belt use and educating the public that air bags are for supplemental protection.

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[1] AIAM represents: American Honda Motor Co., Inc.; American Suzuki Motor Corporation; BMW of North America, Inc.; Fiat Auto U.S.A., Inc., Hyundai Motor America; Isuzu Motors America, Inc.; Kia Motors America, Inc.; Land Rover North America; Lotus Cars USA; Mazda Motor of America, Inc.; Mercedes-Benz North America, Inc.; Mitsubishi Motor Sales of America, Inc.; Nissan North America, Inc.; Porsche Cars North America, Inc.; Rolls-Royce Motor Cards Inc.; Subaru of America, Inc.; Toyota Motor Sales, U.S.A., Inc.; Volkswagen of America, Inc.; and Volvo North America Corporation.

AIAM member company U.S. manufacturing plants include: AutoAlliance International, Inc., Flat Rock, MI; BMW Manufacturing Corp., Spartanburg, SC; Mitsubishi Motor Manufacturing of America, Inc., Normal, IL; Honda of America Mfg., Inc., Marysville, OH, East Liberty, OH; Mercedes-Benz U.S. International, Vance, Alabama; New United Motor Manufacturing Co., Fremont, CA (NUMMI); Nissan Motor Manufacturing Corp. USA, Smyrna, TN; Subaru-Isuzu Automotive, Inc., Lafayette, IN; Toyota Motor Manufacturing, U.S.A., Inc., Georgetown, KY

Air Bag Field Performance

Our members have now had the opportunity to evaluate air bag performance in the real world and to review the field evaluations performed by the National Highway Traffic Safety Administration. These evaluations reveal that air bags are saving lives and reducing injuries, especially serious injuries. The current estimate is that over 900 fatalities have been avoided because of air bags. However, like many other public health actions such as vaccines, medicines, surgery, and even safety belts, the wide-spread adoption of air bags has resulted in a small increase in risk of minor injury, and has caused serious injury and death in certain unusual and rare circumstances. Our members are working diligently to reduce even this small risk to the extent the current regulation and technology allow.

To date there have been a substantial number of abrasions and a small number of eye injuries, forearm and wrist fractures, and other minor injuries due to air bag deployment. Most of these injuries were sufficiently minor that they healed in a short time with no after-effects.

In addition to these there have been 27 fatalities attributed to air bag deployment. Twelve of these have been driver fatalities, and fifteen have involved children, including four in rear-facing child restraints. The driver fatalities have involved some unusual circumstances (e.g., drivers slumped over the steering wheel due to incapacitation from a pre-existing medical condition when the air bag deployed in a crash). Some have involved small stature females with the concomitant condition of old-age frailty. The passenger fatalities have involved children that were against the air bag cover at the time of air bag deployment because they were unbelted or improperly belted, or they were in rear facing child restraints. Rear-facing child restraints are incompatible with air bags because the child restraint is in close proximity to the air bag at the time of deployment. The deploying air bag accelerates the child restraint and child at a high rate that can produce fatal injuries.

It is important to keep in mind the rarity of these fatal incidents. It is estimated that there are over 69 million air bag equipped vehicles on the road, including over 21 million vehicles with passenger-side air bags. These numbers equate to 36 percent of all passenger vehicles on the road with at least one air bag. To date, it is estimated that there have been over 500 thousand air bag deployments. Thus, the air bag deployments resulting in fatalities are only 0.005 percent of all deployments.

A disturbing aspect of these fatal incidents is that most occurred in low speed collisions. We believe that there are near term partial solutions to reduce these incidents and longer term solutions that potentially will essentially eliminate them.

The potential of air bags designed to deploy aggressively to protect unbelted occupants to produce rare injuries and fatalities has long been known by NHTSA primarily based on information supplied to NHTSA by automakers. NHTSA has acknowledged this in several regulatory documents. For example, in a Final Rule issued by NHTSA in 1977 NHTSA stated, in a section discussing possible side effects of air bags, "There is no question that any restraint system that must decelerate a human body from 30 mph to rest within approximately 2 feet can cause injury. Belt systems often cause bruises and abrasions in protecting occupants from more serious injuries." Also in a Final Regulatory Impact Analysis issued in 1984, NHTSA stated, "In summary, the agency concludes that although air bags, on isolated occasions, may cause injuries that may not otherwise have occurred, their overall safety benefits far outweigh this chance occurrence. Air bags are no different from other safety devices in this regard."

Safety Belt Use Legislation and Public Education

All of the passenger side child fatalities occurred because the child was not restrained or was improperly restrained, such as with the shoulder portion of the belt behind the child's back. Also, some of the driver side fatalities occurred because the driver was unrestrained or improperly restrained. What is needed are primary safety belt use laws in all States and increased enforcement of those laws. In addition, a public education campaign is needed to alert the public to the importance of wearing safety belts and wearing them correctly and to the dangers of placing infants in rear-facing child restraints in passenger seats with air bags.

Safety belt use is about 67 percent overall, more for drivers and for passenger cars, less for passengers and for pick-up trucks and similar vehicles. Jurisdictions that have implemented primary laws and have enforced these laws have seen an increase in belt use. For example, California has a belt use level of 85 percent. North Carolina has an aggressive enforcement program coupled with public announcement of the increased enforcement, and North Carolina's belt use has climbed to 81 percent. In Canada, the passage of belt use laws followed by upgrad-

ing to primary laws plus increased enforcement over time has resulted in a belt use level of 92 percent. In studying these activities, NHTSA has found that primary safety belt use laws, aggressive enforcement of those laws, and public information announcements about the law and the enforcement program is the most effective means of raising the level of safety belt use.

We have urged NHTSA to form and lead a coalition of stakeholders to generate public support for and to secure primary safety belt use laws and increased enforcement of such laws, and to conduct a safety belt public education campaign. The member companies of AIAM are ready to support and take part in this effort. This activity will greatly reduce the risk of unbelted or improperly belted occupants being injured by the deploying air bag. It also will greatly reduce the incidents of children being placed in rear-facing child restraints in passenger seating positions with air bags.

Changes to FMVSS 208

When passive occupant protection became a priority for NHTSA and safety advocates, it was primarily because safety belt use was so low and the prospects of increasing usage to a high level so remote. In that environment, the concept of passive crash protection was reasonable, and the drive to promote and mandate air bags was appropriate. The much greater effectiveness of safety belts in protecting occupants in all crash modes now calls into question the strong drive for purely passive occupant protection. However, as stated previously, the additional occupant protection benefits provided by air bags for belted occupants in frontal crashes underscores their desirability and AIAM member company support for air bags.

A holdover from the passive protection character of FMVSS 208 is the requirement in the standard to meet certain injury criteria in a 30 mph frontal impact into a rigid barrier using an unbelted dummy. The need to meet the injury criteria with an unbelted dummy requires rapid air bag deployment. The air bag essentially must be fully deployed to restrain the unbelted dummy, and likewise an occupant in a real world crash, before the dummy, or occupant, moves substantially. A belted dummy, or occupant, would not move forward as much toward the air bag in a test or crash, and the air bag would not need to inflate so quickly to restrain the dummy or occupant. It is this aggressive air bag deployment, necessary to meet the requirements of FMVSS 208, that causes the risk of minor and serious injuries and fatalities to occupants that are in close proximity to the air bag at the time of deployment.

AIAM member companies have conducted substantial research and adopted various features in their air bag systems to try to minimize the effects of aggressive air bag deployment in producing minor and serious injuries and fatalities, and this effort will continue. Air bag fold and deployment patterns have been optimized, advanced air bag cover designs have been incorporated, air bag tethers have been adopted, air bag modules that recede if air bag deployment is restricted have been incorporated, dual deployment thresholds have been used, air bag venting has been optimized, and lower power air bag inflators have been introduced. However, at this time it is not clear that the effects of aggressive air bag deployment made necessary by the unbelted dummy test in FMVSS 208 can be overcome.

It is now time to reconsider the passive protection requirements of FMVSS 208. NHTSA issued a Federal Register Notice for Comments on November 9, 1995, seeking information on approaches to reduce the aggressiveness of air bags. Numerous comments have been provided to NHTSA since that time and NHTSA has met with various auto manufacturers to receive further information. NHTSA has been presented with a number of recommendations to reduce air bag aggressivity from different commentors to the Notice for Comments. All would change the nature of the FMVSS 208 as it relates to passive protection. The recommendations include: 1) changing to a belted dummy test, 2) changing the chest injury criterion, 3) using a standard, moderate crash pulse for an unbelted dummy test, and 4) lowering the unbelted dummy test speed to 25 mph. The belted occupant test is logical because belt use is high and expected to grow higher. The higher chest injury criterion is logical because NHTSA has supporting biomechanical data. In other words, these options all have some logic behind them. Changing FMVSS 208 will greatly reduce the risk of unbelted or improperly belted occupants being injured by the deploying air bag. It also will reduce the risk of serious injury or death to infants placed in rear-facing child restraints in passenger seating positions with air bags.

We believe that NHTSA should establish a partnership with the industry to further develop and choose the best way for changing FMVSS 208. This partnership would evaluate the various options and ensure that, if changes to FMVSS are made, there would be an overall safety benefit to the public. NHTSA can bring to the part-

nership a public policy perspective and its expertise. The industry can bring to the partnership its knowledge of the variety of air bag designs being used by different manufacturers, its vast test capability, and its commitment to continue advancing air bag designs and promoting air bags. We believe the partnership approach aligns with the desires of the current administration and the Congress for a less confrontational, more common sense approach to regulation. NHTSA's recently released draft Strategic Execution Plan calls for more cooperation between NHTSA and the regulated industry. We believe both NHTSA and the auto industry are equally motivated to solve this problem and the member companies of AIAM are ready to help.

Advanced Technology

In the longer term, while advanced technology for "smart" air bag systems may solve most of the rare air bag deployment problems and may allow air bags to be more effective, this technology is only now being developed and its application is unknown. Such "smart" air bag systems could sense seat occupancy, safety belt use, seat adjustment, occupant position, and other parameters and then tailor air bag deployment decisions and air bag deployment characteristics to minimize air bag injuries and maximize air bag occupant protection. NHTSA, in its November 9, 1995 Notice for Comment, requested information on such technology. Some commentors have implied that this technology is nearly ready to go. However, auto manufacturers have indicated that "smart" air bag systems cannot be implemented for a few years. This apparent inconsistency has to do with the incorporation of technology into a vehicle. The suitability and reliability of current technology has not been demonstrated. Further, incorporation of this technology into vehicle designs will require substantial design efforts, especially with regard to the algorithms used to make deployment decisions. These design efforts to incorporate technology into vehicles involves substantial computer modeling and analysis, system design and prototyping, and substantial testing, including many simulated and actual crash tests, before "smart" systems could be implemented and offered to consumers.

It must be remembered that the reliability of "smart" systems must be very high or their failure also may generate air bag performance problems. AIAM member companies are conducting research and development programs on "smart" systems and expect to be introducing them in the coming years if technical and reliability concerns can be overcome.

One near-term application of "smart" technology may have the potential to solve some of the problem of rear-facing child restraints being used in passenger seating positions with air bags. Two AIAM member companies expect to introduce systems that recognize "tags" on specifically designed child restraints and turn off the air bag.

Summary

Thank you for the opportunity to present our views. To reiterate our recommendations and commitments:

(1) NHTSA should form and lead a coalition to secure primary safety belt use laws and increased enforcement of such laws, and to conduct a safety belt public education campaign. We are ready to support such an effort.

(2) NHTSA should form a partnership with the industry to devise a way to revise FMVSS 208 to reduce the consequences of the unbelted dummy test. We are ready to support this effort.

(3) AIAM member companies are committed to continuing research and development programs on "smart" air bag systems.

The first two can greatly reduce the risk of all rare air bag deployment incidents. The third may solve most air bag problems in the long term, if technical and reliability concerns can be overcome. Auto manufacturers are providing air bags in response to market demand and their occupant protection benefits. However, air bag design is dictated in large part by Federal regulation. Automakers have taken extraordinary steps to minimize the rare risks of injury or fatality resulting from that regulation. We believe that manufacturers should not be subjected to product liability risks when they are responding in good faith to a Federal mandate. We urge Congress to address this exposure and to provide a safe harbor for manufacturers who have acted responsibly.

For further information contact: Morry B. Markowitz or, George L. Parker at AIAM, 703-525-7788

The CHAIRMAN. Senator Bryan.

Senator BRYAN. Thank you very much, Mr. Chairman. Let me express my appreciation for your courtesy of allowing me to go early in my round of questions, and I will try to be brief.

Dr. KLIMISCH AND MR. Parker, you are both recommending a change in this airbag deployment standard, FMVSS–208. Do you have a specific proposal that you are advancing?

Dr. KLIMISCH. There are four possibilities that have been proposed by the different companies, and at this point NHTSA is considering those four proposals, which I think were outlined in your testimony.

Mr. PARKER. They are in my testimony, Senator Bryan. I think the important point is, especially within our association, and I do not know about AAMA, but there is not a consensus at this point in time on the best way to make the changes.

I think the other important point is, whatever changes are made, it is necessary to make sure that you are still providing benefits to the public and maybe you can even get greater benefits for the public. That is why we are recommending that NHTSA form a partnership with the industry.

We all have a lot at stake here. We are very committed to airbags. We would like to help the agency make the right decision on how to change 208.

Dr. KLIMISCH. They all go in the same direction, to reduce the energy of the inflator.

Senator BRYAN. I think the concerns have been outlined, and I think they are legitimate.

I must say that, as I understood Dr. Martinez' testimony, he is not prepared at this point to make a change in the standard. He talks about the tradeoffs. That is the last thing we would want to do, to change a standard that, although it purports to address one aspect of the problem, would have a net effect of increasing fatalities, or increasing serious injuries.

Would you comment on that, and are you providing NHTSA with any data in terms of what the analysis that you have done would indicate would occur as a result if each of those standards were changed and, I think, the four ways that you are indicating you are recommending them?

Dr. KLIMISCH. The individual companies are providing that data. As I said, there are always going to be tradeoffs, and ultimately NHTSA has to decide what that tradeoff will be on that.

Mr. PARKER. I think that is a true statement, that NHTSA has to ultimately decide, but I think it is important—our association believes it is important that NHTSA works with all of the manufacturers as a group, and as I mentioned in my statement, in my earlier answer to your question, we would like to see whatever changes are made end up with a net benefit to society, and we think that is possible.

Senator BRYAN. I think we all would.

I guess there are some of us who remember that it took us 30 years to get airbag legislation. The industry consistently opposed it up until the very end.

There is always, I suppose, some reluctance to readily embrace a proposal without being very careful to consider what the impact is. There is a concern that has been raised. I think it is a legiti-

mate concern, but we want to make sure that we do not, in making a change, exacerbate safety with respect to fatalities or serious injury.

Mr. O'NEILL. Senator, could I just perhaps add something on this, not being a manufacturer, and not having a vested interest. We want to see airbag effectiveness improve. The energy levels of inflators in most cars today are determined by the unbelted test of FMVSS–208. This is a 30-mile-an-hour test of a very perfectly seated dummy back in the seat.

There is no pre-impact braking, there is no pre-impact jostling of the vehicle, and the test in effect determines the energy levels necessary to provide protection for someone in those circumstances.

Our recent in-depth analysis of fatal crashes where people are dying despite the presence of a deployed airbag indicates that in a large number of cases unbelted occupants, drivers and passengers, are no longer in that position at the point the airbag deploys, and in a wide range of crashes they are in the path of the deploying airbag.

In many of these cases, rather than being protected by the airbag, they are, in effect, being injured by the airbag.

We very strongly believe that, by reducing the energy level in the inflators, we would increase the protective capabilities of airbags for unbelted occupants. We would not be degrading that protection. It is because the unbelted test of FMVSS 208 right now is not a very good surrogate for what is happening to large numbers of unbelted people in real-world crashes.

Senator BRYAN. I am certainly not suggesting that some modifications may not be an improvement, but I gather from Dr. Klimisch's comments that the individual auto makers, as opposed to the association just making proposals—and I guess my question, without getting involved in all of the technical nuances, are each of you saying that you agree as to what the changes ought to be, or are you just saying that, look, you think there needs to be some modification with respect to this particular FMVSS–208 standard?

Mr. PARKER. Senator Bryan, I think that there is not a consensus in the industry on what the best change is, and again, that goes back to the partnership approach. We are working with NHTSA to try to come to a consensus. There are good points of all of the proposals that have been made, and I think even within the associations, as Dr. Klimisch has said, there have been different proposals from different manufacturers.

I know in discussions with our members, when they review these, they say, well, we do not like that one, but we like this one, but I think it is just important to sit down with NHTSA and discuss all these things, and everybody put the data on the table and make a decision.

The other thing I think you have to keep in mind as a partner to the change to 208 is the increasing level of safety belt use, and we think that when you partner the increasing level of safety belt use with changes in 208, that that is the best chance of getting a better societal benefit for safety.

Senator BRYAN. Mr. O'Neill, is that essentially your position as well, that you think there should be some modification, but the specifics are subject to further discussion and analysis?

Mr. O'NEILL. I think there is no question that the precise modifications to FMVSS 208 should be decided and discussed among the various stakeholders. Our position is that right now everything we see suggests that the unbelted test is the constraint on the designs. We would like to see that become less of a constraint so there is, in effect, more design freedom for the manufacturers.

Senator BRYAN. Mr. O'Neill, let me ask you a couple of questions. The variation of seat-belt usage, I mean, even among those States that have secondary State enforcement systems, is just enormous.

Mr. O'NEILL. Yes, it is.

Senator BRYAN. What accounts for that?

Mr. O'NEILL. I think there are a number of reasons. We know, for example, that the education level of people is a very strong determinant of seat-belt wearing. If you observe seat-belt use in affluent communities, you will find very high levels of best usage. If you observe seat-belt use in poorer communities, you will see lower levels of use. Part of this is a denial of the risk of some people, but clearly, the only way we can get large numbers of people buckled up, and this is not just only true in the United States, it is true around the world, is by having seat-belt laws and the public perceives there is a risk of getting a ticket. They are more likely to buckle up in response to the threat of a ticket than in response to the threat of being in a crash and being injured.

There are a number of coalitions around the country now that involve insurers and other consumer groups trying to change laws from secondary to primary enforcement. There is no question in my mind that if you tell the public we have got a seat-belt law but it is secondary, we really are not very serious about enforcing it. That sends a message that we are not yet serious enough about seat-belt use.

We believe very strongly that primary laws with good enforcement and associated education and information are what is needed to do what has been accomplished in Canada. In Canada, our neighbor to the North, they have over 90 percent belt use in all of their provinces. They have done it through laws, enforcement, and education. I think you have got to have all three to make it work.

Senator BRYAN. My last question, Mr. O'Neill, is there any data that would indicate to us that in those States that have a lower seat-belt use that there accident/medical related cost, either in terms of hospitalization, medical care, and particularly with respect to those that are publicly funded such as Medicare and Medicaid, that those costs are higher, either per vehicle mile traveled or on a per capita basis? Is there any data?

Mr. O'NEILL. Unfortunately, State-to-State comparisons are very, very difficult because of different data systems.

So it is not possible to say that in State A they are paying more out of the public funds because of this problem than in State B. You cannot say that directly, but indirectly there is a wealth of evidence indicating that a State with a lower level of belt use is going to be paying more in Medicaid,

Medicare, and subsidized medical bills because of the people who are refusing to buckle up. Those of us who buckle up are subsidizing those who do not.

Mr. PARKER. Senator Bryan, just to add a little bit to that, NHTSA completed a study recently in I believe seven States called Crash Outcome Data Evaluation System. CODES is the acronym. I believe they recently released a report that would provide some of those numbers you are interested in. I think if you ask NHTSA they can provide that for you.

Senator BRYAN. I thank you, Mr. Parker.

Mr. Chairman, I thank you very much for your courtesy, and I thank the panel, as well.

The CHAIRMAN. Thank you very much.

Mr. O'Neill, you indicate Mercedes and BMW are using a more sophisticated electronic sensor, located inside the vehicle's occupant compartment, which connects to the buckle sensors on the safety belts. The apparent advantage of this sensor is that it triggers air-bag deployment at different rates, depending on whether the passenger is unbelted or belted. You also indicate the location of these sensors result in fewer unnecessary deployments of the air bag. Are these types of sensors available in cars sold in the United States? If not, are there regulatory hurdles that need to be overcome which would permit this type of sensor to be used in the U.S., and how much do these sensors add to the price of a car?

Mr. O'NEILL. There are no regulatory constraints on the use of these sensors, and more and more manufacturers, both import and domestic, are moving to what is called a single-point sensor; that is, they are moving away from the sensors that are typically arrayed out toward the front end of the vehicle.

I am not yet aware of many manufacturers that are using belt buckle sensors to tie back into this single point crash sensor to change the deployment threshold for belted and unbelted occupants. We think that is important. We encourage all of the manufacturers to begin to move in that direction, because you do then eliminate a number of unneeded deployments for belted occupants.

Admittedly, the risk of inflation injuries is highest for unbelted occupants, but there are still risks for some belted occupants, particularly some of the arm injuries, for example, that we heard about this morning. Many deployments for belted occupants can be eliminated if you have a higher deployment threshold based on belt use.

The CHAIRMAN. Are those Mercedes and BMW's safer cars to ride in than our cars?

Mr. O'NEILL. I would not characterize them as safer, but I would say that there is, almost by definition, a somewhat lower risk of an inflation injury because there will be fewer inflations. At the same time the occupants, because the fewer inflations will involve belted occupants, will not receive any less protection.

The CHAIRMAN. What about the cost that those sensors would add to the price of a car?

Mr. O'NEILL. I think that everybody is moving in a direction of single-point sensing. I think some of the early single-point sensors were more expensive than the electromechanical sensors at the front end of the vehicle, but it is my understanding that single-point sensing is getting less and less expensive all the time.

It is important to understand, however, Mr. Chairman, that it is not a simple change for a manufacturer to go from one kind of sen-

sor to another. You do not just do this. These kinds of changes will typically occur upon a redesign of a vehicle, because the whole system, the air-bag system, the certification of the system, is based on the complete system interacting with the structure of the vehicle. So if you have designed the car to have electromechanical sensors at the front, you cannot just quickly change to a single-point sensor.

But my prediction is that as we see more and more new platforms introduced we will get more and more cars with single-point sensors.

The CHAIRMAN. Does anybody else have a comment on that?

Mr. WILBER. Yes, I would like to comment, if I could. First of all, it is a level of technology that is known through the industry. There are certain platforms, not just whether they are current or being redesigned, that that kind of technology may be effective in. There are other platforms where it may not. In fact, it is just that struggle of defining what kind of technologies to apply to a given car that requires the kind of regulatory flexibility that we may be seeking with the Agency, and why we do not have a single answer for a technology solution right now today.

We have our best technical minds working with the best technical minds at NHTSA on defining a variety of new technologies that could address both air-bag aggressivity, as you may want to call it, and improved occupant protection. So it is this continuing issue of balance and achieving that balance that we are seeking.

The CHAIRMAN. I guess I would ask any of you, is there anything we should learn from how other countries regulate air bags? Is anybody doing it better than we are?

Mr. PARKER. Well, the one thing that is different in some other countries is that they have a belted occupant test, so that allows inflators to be less aggressive, air bags to be less aggressive.

The CHAIRMAN. What is that? What does that mean? What is that test that they use?

Mr. PARKER. NHTSA's test in 208 is an unbelted 30 mile an hour rigid barrier test. In other countries, for example Japan and Australia, they have a test that is the same test essentially but with belted occupants. That allows the air bag to be less aggressive, to have the less powerful inflators.

One of the primary reasons for that is that belt use is much higher in those countries. That is why, as I said earlier, you really need—on an overall basis, we are recommending the activities to have primary belt laws and greater enforcement so you can get to the point where I think the public would be able to feel comfortable, and we can all agree that you get greater benefits by making these types of changes.

Mr. O'NEILL. Mr. Chairman, let me add something there. I think it is very important to understand that the United States leads the world when it comes to the implementation of air bags. The number of air bags on the road in this country vastly exceeds the number of air bags on the road in the rest of the world. The rest of the world has basically been following, not leading, the U.S. when it comes to the implementation of air bags.

There are no requirements in any other country that mandate air bags. Yes, they do have crash tests that only require testing with

a belted occupant. In the U.S., we require the manufacturers to test both belted and unbelted, and there is a question, as you have heard, as to which of those tests perhaps should be governing the technology.

But I believe that the rest of the world is still learning from us, and we do not have much to learn from the rest of the world at this point.

Mr. PARKER. Except how to increase safety belt use. But I think we have studied that enough to know how to do it. It is just a matter of applying it in the U.S.

Mr. WILBER. Mr. Senator, let me just enforce what was said. There are no regulations requiring air bags as exist in the United States. Air-bag fitment, though, due to customer demand and the recognition of the safety improvements that they offer is, in fact, expanding around the world. There are standards around the world that are patterned somewhat after our 208 in the areas of Australia and Japan that are a full frontal crash belted only, and if you have an air bag that is OK, but you do not have to have one. It does require a level of measurement on the dummy similar to ours, so it is an assessment of the restraint system performance, but not a requirement to actually fit the air bag.

In Europe, they are looking at a totally different test protocol exercising an offset crash with similar criteria to 208. That is still currently being debated within the European Parliament.

Mr. O'NEILL. Mr. Chairman, it is also worth adding that we often hear in this country that regulations are a problem and that we have too many regulations. We have air bags now increasingly available, and around the world the U.S. led this. It did so initially through regulation. We have created a very successful U.S. export industry.

Large numbers of the suppliers that are supplying manufacturers around the world with air bag components and air-bag systems are U.S. companies. These are companies and this is a business that was created by a Federal regulation. It is now driven around the world and in this country by marketplace demand. But it was put in place by a regulation.

The CHAIRMAN. Dr. Klimisch, you indicated it might be necessary to fine tune air-bag regulations. Do your member companies have a unified proposal for how these regulations might be modified?

Dr. KLIMISCH. Well, not yet. There have been a number of proposals. I am sure we are going to converge very quickly on that. The process was that everybody send their ideas to NHTSA in response to their request, but they are all in the same direction. I do not think that is going to be a problem to converge.

The CHAIRMAN. In response to the National Highway Transportation Safety Administration's recent call to action, your organization, in conjunction with the AIAM, proposed an effort to encourage the proper use of safety restraints. That effort would be led by NHTSA, but funded by private industry as I understand it. I understand that there is a proposed funding level of $21 million with the automobile manufacturers supplying approximately $10 million of those funds, is that right? How is that going? How is that going to work?

Mr. WILBER. Let me speak to that just a little bit. Certainly, NHTSA immediately wanted to bring the interested parties together and say what can we do. Based on our experience in the past with promotion of primary seat-belt use laws or seat-belt use laws in general through the traffic safety now activity, we went to NHTSA and said based on some experience here we think that if an expenditure of something around $21 million is put forth that certain benefits could be derived. A number of States could be brought in line and some public information can be put out, and it seemed like based on our experience that would be a good amount.

NHTSA is anxious to take the lead and form a coalition of interested parties, and between ourselves and AIAM we volunteered that from the auto industry's stake we would pick up half of that tab and look for insurance to contribute, as well.

The CHAIRMAN. Would any of you comment on the so-called smart bag technology that might be available for use in average vehicles? What is the smart bag technology.

Mr. PARKER. Well, Mr. Chairman, all our members are working on smart air-bag systems, if you will. A smart air-bag system is one that uses sensors, for example, to detect whether there is a person in the seat, a safety belt is used, where the seat adjustment may be, the location of the occupant relative to the air bag, and it would use that information to make decisions on whether or not to deploy the air bag, and the characteristics of the air-bag deployment.

Those decisions, for example, if there is a rear-facing child restraint, the decision would be not to deploy the air bag. If there is a severely out-of-position occupant right up against the air-bag cover, for example, the decision would be not to deploy the air bag. In some other cases the air-bag deployment would be tailored to where the driver or the occupant is. So those all have a lot of potential to have a lot of benefit.

The problem is that to introduce that type of technology into an actual vehicle is not an easy task. You have to do a lot of modeling of the vehicle crash characteristics; you have to do a lot of prototyping of hardware; you have to do a lot of testing. Essentially, what the bottom line is, you are trying to make sure that those systems perform as reliably to the point that you are not going to have problems because you have a smart air-bag system.

In other words, let us say it makes a wrong decision and does not deploy the air bag when everything is right for the occupant. So manufacturers must be assured that that technology is ready for vehicles, is well designed in the vehicles. I think the thing that is important here, the number of fatalities that have been experienced to date from air bags where drivers and passengers have been out of position, compared to the total number of deployments, it is less than 1/100th of a percent of all deployments.

So a smart system has to be better than that to make sure that you are actually having benefits and reducing those 27 fatalities that we now are aware of. It is just not an easy task to do.

The near term thing, a couple of our members are going to be introducing probably in 1997—actually in calendar year 1997—are our systems where you would have a rear-facing child restraint or forward facing that would have a tagging system on it and a sensor

in the vehicle to detect whether it is a forward-facing or rear-facing child restraint, and then make a decision based on whether it is forward-facing or rear-facing to turn off the air bag. That is probably the earliest that you have.

Mr. WILBER. Let me add to that in trying to define this term smart air-bag system I think it is important to recognize that this is going to be an evolutionary process. One would argue that today's air bags are smarter than those of 10 years ago, and 10 years from now the bags will be smarter yet. It will include sophistication of electronics, as Mr. Parker just mentioned, trying to tune the environment better. But there will have to be, and I think it is important to recognize that, even with the advent of more intelligent or more sophisticated systems, that occupant position is still a clear element that needs to be controlled, and seat-belt use is the way you do that.

You cannot get away from that, and I would not want to leave an impression that some kind of smart air bag is going to eliminate the need to continue to push for improvements in seat-belt use and primary use laws and all the other activities that we are aiming at as a short-term gain. They will be good now and in the future.

Mr. PARKER. In the meantime, I think both AAMA members and our members are working to study and incorporate into their current design, for example, different fold patterns of the air bag, different cover designs, et cetera, to try to minimize the effects of aggressive air-bag deployment and out-of-position occupants.

The CHAIRMAN. Let me ask all of you that philosophical question that I asked earlier. It seems that we lose about 41,000 people a year in automobile crashes. We have such a huge emotional reaction to the loss of far fewer lives. Of course, the loss of any life is tragic, and we need to investigate it and be concerned. But if there is a plane crash or a train crash or accident, it catches the imagination of the public and the need to do something about it. Whereas it seems that we have almost come to the point of acceptable losses in automobiles; maybe it is because we move so many people around.

Obviously, if you are moving that many people around at fairly high speeds there are going to be some accidents in the course of human affairs. But people seem to be very unwilling to give up their freedom, to get in that car and go as fast as they want, talk on the phone or whatever; the car sort of sets people free for a few minutes or hours. What is it in our culture that we are not as horrified at the loss of people in car accidents as we are in the other modes of transportation?

Dr. KLIMISCH. The other side of that, in the 1930's the fatality rate was 15.6 fatalities per 100 million miles. We are now down to 1.7 or 1.8. That is equivalent to one fatality for 20,000 trips between San Francisco and New York. So it is a very rare event. The exposure is enormous. That is why we get to 40,000. But it comes down to habits. People do not change habits very easily, smoking and eating the wrong foods and all those things are examples, but change in habits, change in behavior, is very difficult. That is presumably why we have to resort to enforcement. No one wants to do that, but that seems to be the only way one can change those habits in a short period of time.

Mr. PARKER. Perceived risk seems to be something that drivers just do not acknowledge. It is such a rare event for most people to be in even a serious crash, or even a minor crash for that matter. They do not perceive the risk of driving as being hazardous.

Mr. O'NEILL. Airplane crashes are very rare events, but many people who get on an airplane are apprehensive and somewhat concerned, and especially so if there has been a crash recently that has had a lot of publicity. I think that the difference is you feel you are not in control of your destiny on the airplane, but people tend to think they are in total control of their destiny when they are behind the wheel.

If you ask a group of individuals, how many of you are below average drivers, no one will admit to being a below average driver. If you ask people, is highway safety a problem that deserves attention; they answer yes, it is. We have got to go out and deal with all those bad drivers and that big problem out there. But it is not my problem, it is always somebody else's problem and somebody else's risk.

Dr. KLIMISCH. I wonder why people wear seat belts on airplanes and not in cars? They do a lot more good for them in cars. But of course the answer is they make you wear the seat belts on airplanes.

The CHAIRMAN. Gentlemen, this has been very useful. I thank you very much for your testimony here today. There will be additional questions for the record.

The CHAIRMAN. I call this hearing to an end. Thank you very much.

[Whereupon, at 11:25 a.m., the hearing was adjourned.]

APPENDIX

Questions Asked by Senator Pressler and Answers Thereto by Ricardo Martinez, M.D.

Question 1. Many South Dakotans drive pickup trucks and sport utility vehicles. As an agricultural state, we have many rural roads which are often unpaved and rough. Currently, very few of the vehicles used on these roads have air bags. What measures have been taken to ensure we won't be seeing a number of injuries as the result of premature, unnecessary air bag deployments on these vehicles when the law mandates them in model year 1999?

Answer. To date, NHTSA has received seven reports of premature or unnecessary air bag deployments with respect to pickup trucks and sport utility vehicles. One manufacturer initiated a voluntary recall in 1993 to resolve this problem. The agency monitors consumer complaints dealing with all air bag deployments, and we share this information with the manufacturers to assist them in improving the field performance of air bags. We believe that sharing this information helps to minimize any unnecessary air bag deployments. In all cases, injury from a premature air bag deployment will be minimized if the occupant has the safety belt securely fastened.

Manufacturers also take active steps to minimize the risk of inadvertent air bag deployment. They design pickup trucks and sport utility vehicles to operate not only on rural roads that are often unpaved and rough, but for police activities, ambulance service, or other rescue missions involving extreme conditions and circumstances. Accordingly, we do not believe that any additional measures are needed to avoid unnecessary air bag deployments concerning these vehicles.

Question 2. There have been reports of premature, injury causing, air bag deployments. What are the steps involved with data collecting regarding air bag related injuries? Why do there appear to be some air bag deployment accidents "slipping through the cracks" in relation to NHTSA's data collection mandate?

Answer. To date, NHTSA is aware of 167 reports involving largely minor injuries due to premature air bag deployments. From 1990 through 1995, the relatively few reports of this problem have decreased significantly in proportion to the total number of air bag-equipped vehicles on the road. In addition, there have been some instances of serious and fatal injuries caused by normal air bag deployments. NHTSA is very concerned about all of these injuries, and we are carefully monitoring the real-world performance of air bags. At the same time, however, we believe that our current data collection efforts are doing an excellent job of identifying serious crashes where air bags have deployed. There are approximately 6.5 million police reported crashes each year. We believe that, given available funding, the agency's multi-tiered approach to investigating and analyzing air bag related injury crashes minimizes the probability of "accidents slipping through the cracks."

The agency uses three distinct data collection programs to investigate and analyze air bag related injuries: the Fatal Accident Reporting System (FARS); the National Accident Sampling System Crashworthiness Data System (NASS CDS); and, the Special Crash Investigation (SCI) program.

The FARS program contains data on a census of fatal traffic crashes throughout the country, and includes information from police reports, death certificates, State Highway Department roadway data, and driver licensing data. The FARS program is based on police accident reports. NHTSA continues an effort, begun in October

1995, to review police accident reports and other information collected by the FARS analysts in each state to determine possible cases of air bag related injuries. The FARS program collects data regarding approximately 40,000 crashes a year and is the primary data source for evaluating the fatality-reducing effectiveness of automotive safety features.

The NASS CDS has positioned crash investigation teams throughout the Nation in sites representative of the geographic and demographic characteristics of the country. These teams collect vehicle and occupant crash data on a statistically representative sample of all tow-away crashes involving cars, light trucks, and vans. Currently, 24 teams utilize nearly 60 researchers to conduct approximately 5,500 investigations per year. In 1996, approximately 2,200 of these crashes will involve an air bag deployment. The data collected during the course of a NASS CDS investigation include scene, vehicle, occupant, and injury information. These data are collected on standardized forms with rigid guidelines to ensure consistency and accuracy in recording the hundreds of data elements. The NASS CDS program is the primary data source for evaluating the injury-reducing effectiveness of automotive safety features.

The SCI program has been conducting clinical in-depth crash investigations involving air bag equipped vehicles since 1972. The SCI program has provided NHTSA with the most in-depth and detailed level of crash investigation data collected by the Agency. Hundreds of data elements relevant to the environment, roadway, vehicle, occupants, injury mechanisms, and affected safety systems are collected for each of the 50 to 75 crashes designated for annual study. The SCI cases are intended to be an anecdotal data set useful for examining special crash circumstances or outcomes from an engineering perspective. The benefit of this program is that it provides us with the ability to locate unique real-world crashes anywhere in the country, and enables us to perform in-depth, clinical investigations in a timely manner that can be utilized by the agency and the automotive safety community to improve the performance of state-of-the-art safety systems. The SCI program's identification and presentation of new injury patterns associated with air bags has stimulated research at a number of automotive safety laboratories, and resulted in significant design changes to present air bag systems.

NHTSA takes special steps to identify air bag crashes that result in an unusual injury pattern. To accomplish this, we actively network with the health, law enforcement, media, vehicle manufacturing and insurance community to increase our awareness of these crashes. Some examples of these efforts include close communication with other organizations that receive reports of air bag related injuries, including: the National Transportation Safety Board; the Insurance Institute for Highway Safety; the University of Michigan's Transportation Research Institute; and automobile manufacturers. We are also seeking to expand our networks throughout the law enforcement, medical examiner, and physician communities. Additional efforts also have been initiated by our Auto Safety Hotline and Regional Operations staff to identify air bag crashes that result in an unusual injury patterns.

Question 3. Is there any new technology being developed which might replace our current air bag/safety belt restraint system all together in the future?

Answer. NHTSA is not aware of any new technology under development that has the potential to replace our current air bag/safety belt restraint system.

Question 4. I understand there has been at least one instance where a child was killed because an air bag deployed in a slow speed crash which might have otherwise caused little or no injuries to belted passengers. Does NHTSA regulate the "trigger speed" (the speed which a vehicle must be traveling in an accident before an air bag deploys) for air bag deployment? If we were to assume passengers are wearing their safety belts, how much higher could this speed be and would there be a significant benefit?

Answer. NHTSA's Federal Motor Vehicle Safety Standard No. 208, "Occupant Crash Protection," does not regulate the "trigger speed" of air bag deployment. Under the standard, manufacturers may select air bag deployment thresholds, consistent with their overall vehicle design philosophy, to satisfy the standard's safety performance requirements. Some manufacturers today set a single deployment threshold for all their cars; others specify different thresholds for each model. Some manufacturers, such as BMW, use different deployment thresholds depending on whether the passenger is belted or unbelted, while suppressing deployment entirely in the event of an unoccupied passenger seat.

NHTSA's November 1995 "Request for Comments" dealt extensively with the general issue of air bag aggressivity. The comments we have received on our questions concerning changing deployment thresholds do not show a general technical consensus. While some commentors pointed out that higher deployment thresholds would reduce the frequency of air bag-induced injuries at lower speeds, others argued that

higher deployment thresholds could force air bags to be more aggressive when they deploy. Based on these responses, it is not clear that raising the air bag deployment threshold would correct the problem of air bag aggressivity. In short, a "one size fits all" approach may not resolve the conflicting and often contradictory technical requirements involved in reducing the adverse effects of air bag deployments. Currently, we are completing our analysis of data provided from our request for comments, our subsequent meetings with vehicle manufacturers, and from test programs underway in the agency and elsewhere.

Question 5. Are auto manufacturers currently, or planning to offer shutoff switches for the passenger-side air bags? Is this a safe practice? Will the new regulations prevent manufacturers from offering this option?

Answer. Federal Motor Vehicle Safety Standard No. 208, "Occupant Crash Protection," now provides manufacturers with the option of installing a cut-off switch to suppress the deployment of the passenger side air bag under two unique conditions: (1) if the vehicle has no rear seat; or (2) if the vehicle's rear seats are too small to accommodate a rear facing infant seat.

The Ford Motor Company currently offers a cut-off switch for the 1996 Ford Ranger and the 1997 Ford F-150 pickup truck. Mazda provides the cut-off switch for its 1996 B-series pickup trucks.

Because the agency was concerned about the possibility that cut-off switches could be misused, we established the following safeguards: (1) the cut-off switch may be operable only with an ignition key (allowing only the driver to deactivate the air bag); and (2) a yellow warning light on the dash must display the words "Off" or "Air Bag Off" when the air bag is deactivated (so that both the driver and any passengers will be aware that the air bag is off). We have seen no indication that 1996 and 1997 model year vehicles on the road with this cut-off switch have been misused by the public.

The current requirement in our standard prohibits manufacturers from offering cut-off switches in passenger cars, as of September 1, 1997, and prohibits the cut-off switch option for light trucks, as of September 1, 1998. NHTSA is currently considering whether those dates should be extended, in view of the need to accommodate parents of children with medical conditions that require the child to be transported in the front seat. The agency has not yet decided what it will propose in this area.

Question 6. What methods of air bag inflation are currently available? Do advances in the air bag inflation technology promise to produce a safer air bag?

Answer. The two basic methods of air bag inflation in current use are stored gas inflators and pyrotechnic inflators. The vast majority of vehicles are equipped with the sodium azide-based pyrotechnic inflators. Stored gas inflators utilize highly pressurized gas in a container. In the event of a serious crash, the container is punctured and the gas fills the bag. The pyrotechnic inflators utilize a propellant that is ignited in the event of a serious crash. The burning of the propellant gives off gases that fill the bag. More recently, however, manufacturers have been examining propellants other than sodium azide due to environmental and other concerns.

Manufacturers are investigating a number of approaches to produce a safer air bag. One concept reduces gas flow during the early phase of the gas generation, and then slowly increases the gas flow. Another concept employs multiple stage inflation, using several inflators. In this latter concept, the first inflator provides a low level of gas flow to initiate the deployment of the bag. A second inflator is then ignited to complete the air bag deployment, but not enough to be injurious. The pursuit of these and other concepts will provide safer air bags in the future.

Question 7. Currently, electromechanical sensors are used to trigger air bag deployment after a crash begins. I understand there is technology being developed which would employ sensors that trigger air bag deployment before a crash begins, swiftly curbing the number and severity of air bag related injuries. When can we expect to see this technology come to market?

Answer. Technology that provides sufficiently reliable pre-crash sensing should be available in about 9 or 10 years. Current developmental efforts are focused primarily on identifying the speed and direction of a pending collision. More advanced research has been initiated for identifying and determining the weight of this partner. These efforts, combined with interior occupant position sensors, will culminate in "smart" air bag systems that may substantially reduce the number and severity of air bag related injuries.

OTHER MATERIAL SUBMITTED FOR THE HEARING RECORD

LETTER SUBMITTED FOR THE HEARING RECORD

EDWARD J. DONLON
ATTORNEY-AT-LAW
C/O CONGDON, FLAHERTY
377 OAK STREET
GARDEN CITY, N.Y. 11530

MARCH 19, 1996

United States Senate
Commerce Committee
425 Hart Office Building, Washington, DC 20510

RE: AUTOMOTIVE AIRBAG INJURIES

DEAR MR. GILLIGAN: We discussed on the telephone the profound injuries suffered by Mary Riordan, my client, solely because of the deployment of the air bag in her 1989 Chrysler LeBaron. Mrs. Riordan wishes that note of her suffering be made in your Committees Hearing Record on the subject of air bag related injuries because she prays that public awareness of her plight might help others in the future.

Mrs. Riordan was operating her Chrysler on December 20, 1993. She was stopped in traffic when the air bag deployed. The attendant of an ambulance, which just happened to be passing, saved her life: he found no respiration and no pulse but, after cutting Mary free from the safety belt she had been wearing, he was able to revive her. The deploying air bag caused a severe fracture high in her neck. She sustained a C-2, type II fracture, which extended completely through the base of the odontoid process, with extreme C-1/C-2 dislocation. She suffered brain stem and spinal cord injury. At a local hospital, Mary underwent several extraordinary surgical operations: screws were driven through the C-2 fracture and her neck was fused. After two months, Mary was transferred to Mount Sinai Medical Center in Manhattan where she underwent months of extensive physical therapy. Mary is now an incomplete quadriplegic, unable—at the age of 57—to care for herself.

We greatly appreciate your kind interest and your courtesy.

VERY TRULY YOURS,
EDWARD J. DONLON

STEPHEN T. LONG
XSCI, INC.
143 SINTON ROAD
COLORADO SPRINGS, CO 80907.

Dear MR. GILLIGAN:

Thank you for your offer to include a description of our infant seat technology in the Record. I've enclosed two items which you can use as appropriate:

1. The Inside Automotives (Mar/Apr 1995) article "We're Getting Close to an Airbag Safe Infant Seat" describes the technology underpinning our infant seat. The seat has been much improved during the last year.
2. The letter to Dr Martinez speaks for itself and includes some of the latest test data.

Please feel free to contact us if you need any more information concerning what is now called the **GOOR**™ Seat.

Sincerely, Stephen Long, System Architect

MARCH 7, 1996

Dr. RICARDO MARTINEZ,
Administrator
NHTSA

DEAR DR. MARTINEZ: I am in receipt of your letter to Congresswoman Schroeder of Colorado; in simple terms, Dr. Martinez, your response suggesting that industry fund our program is unrealistic without impetus and help from NHTSA!

This morning on CNN a story regarding a child that was killed by a deploying airbag was aired. The family will be suing General Motors (GM) and Morton International. GM received a presentation of an airbag compatible infant seat in October of 1995. GM just last month completed a copy of that seat which will be tested after its expert on child restraints, Dr. John Melvin, returns from vacation. Last Friday we saw Dr. Melvin who without equivocation agreed that our seat concept is sound!

Morton International ran a number of tests on our seat on behalf of Chrysler. Even very severe tests at 35+ MPH (70% above CRABI guide-lines demonstrated numbers well below FMVSS 213. Tests ran at Chrysler and in Europe at speeds between 30 to 31 MPH, consistently yielded numbers generally within the CRABI task force guide-lines.

Without deploying airbags, at 35+MPH, our seat at Morton tests yielded HIC and deceleration numbers measurably below that of the most commonly used conventional infant seat. Dr. Melvin commented to us, that based on our concept, these results should not be a surprise.

Last week I presented a paper describing the airbag compatible infant seat at the SAE Annual Congress. The paper was quite well received. Even Kathy Weber of the University of Michigan, the first person to bring to the forefront of public attention, based on CRABI testing and initial NHTSA warnings, the incompatibility of deploying airbags and conventional infant seats, stopped by to see me after the presentation to express her support. Kathy Weber, incidentally, is scheduled to run additional tests on our behalf, providing we can find the ends required to continue with our program.

It is quite interesting to note, Dr. Martinez, that in spite of many fewer passenger side airbags per vehicle in Germany, a German child restraint company is more active than anyone is in the US, aid is about to sign a license with us. Germany should have our airbag compatible infant seats on the market by next summer; when will they be available in the US?

At your request, on a separate page, I am enclosing a data overview of the nearly twenty tests that have been run to date. From a technical stand point, Dr. Martinez, our seat is a passive unit, unlike bypass switches which will fail. Our seat, by industry estimates, should cost not much more (20 to 30%) in production than conventional infant seats do.

Our financial exposure so far is upwards of $250,000.00. We cannot, on our own, continue to support this program. As much as we are public-spirited citizens and would like to save infants lives, our investors cannot continue to carry the program without outside help. Your letter to Congresswoman Schroeder states that you "cannot offer funding at this time". Do you have to wait until scores of infants are injured or killed by deploying airbags before funds can be made available?

The law-suit in Utah (the one mentioned this morning on CNN), the one against GM and Morton could probably gain significant momentum if the plaintiffs and the media were aware that both GM and Morton knew of the fact that an airbag compatible infant seat could have been made available, with nominal investment by industry, before their infant was killed!

Do we have to wait until the public outcry is so loud that industry and Government have to come to us and help us complete our work on the infant seat? Or, Dr. Martinez, can NHTSA find the funds needed to complete our work from such sources as SBIR; R&D funds, or jointly from you and industry? We can have a seat ready for market for some $700,000; with your support, even though on our own we are unlikely to be able to get additional funding, we think we can arrange for nearly half of the amount we require to come from a highly credible engineering firm with whom we are associated. If we start now, seats can be ready in time for introduction of the 1997 vehicles.

Let me end by telling that the Chrysler safety expert, Mr. Howard Willson, suggested that it is time for him to arrange a meeting for us with NHTSA. What he suggests is that it is time for regulations to be drafted to accommodate our seat. Mr. Willson stated that the data we have on hand should be quite sufficient to support new regulations.

Very sincerely yours,
E. Patricia Goor, CEO
XSCI, Inc.

ATTACHMENTS TO DR. RICARDO MARTINEZ LETTER

OVERVIEW:

SLED TESTS OF **GOOR**™ AIRBAG COMPATIBLE INFANT SEAT

Inasmuch as those in Germany running our tests do not want to be pressured by the German Automobile industry to drop all they are doing in favor of getting the **GOOR**™ Seat ready for market, the specific major German automobile companies who ran the tests cannot be named at this time. The last two tests which were run in Germany, were conducted by major German automobile manufacturers in conjunction with BRITAX/ROMER of Ulm, Germany:

Seat#	Velocity	HIC	Head Acceleration (3MS)	Chest Acceleration (3MS)
#2	32 MPH	450	45.6g	47.0g
#3	31 MPH	310	41.9g	45.8g
#6	30 MPH	139	41.6g	45.6g
#6a	34+ MPH	334	55.6g	51.1g

In tests that were ran at Morton on crashes without deploying airbags (conventional and #7) and in Germany (#5 and #6), comparing the **GOOR™** Seat[1] to conventional seats, data consistent with tests in Germany showed:

Seat#	Velocity	HIC	Head Acceleration (3MS)	Chest Acceleration (3MS)
#5	31mph	569	64.6g	64.4g
#6b	32mph	450	61.4g	47.6g
Conventional	35+mph	844	102.7g	49.5g
#7	35+mph	424	78.1g	41.3g

ATTACHMENTS TO DR. RICARDO MARTINEZ LETTER

'WE'RE GETTING CLOSE TO AN AIRBAG SAFE INFANT SEAT' AND

INVESTOR'S BUSINESS DAILY

[Articles follows:]

[1] Without an attempt to optimize for a crash without deploying airbag.

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TECHNOLOGY SPOTLIGHT

'We're Getting Close to an Airbag Safe Infant Seat'

Recent tests at Chrysler prove infant seats and airbags can be compatible

by Stephen T. Long, GA International Inc.

Last December a newly designed infant seat was tested by GA International, Inc. (GAI), in conjunction with Atoma Interior Systems, at the Chrysler Chelsea testing facility. Without any attempts at optimization, the seat was placed in a Viper cockpit using a six-month old CRABI (Child Restraint and Airbag Interaction).

The test results were quite astonishing in this worst-case scenario video and telemetry output. It proved an infant can survive the airbag-infant seat interaction in the new GAI design. Test results suggest there may be no need for a manual (or automatic) passenger-side airbag shutoff switch after all.

It's no secret that restraint systems in vehicles are designed for adults, not small children (the integrated child seat first introduced in Chrysler minivans is an exception). Small children, because of their size, anatomy, and tolerance to trauma, are not protected by adult restraints systems. Thus, aftermarket child restraint systems were developed.

For infants (newborn to 20 lb., or approximately one year old), the typical restraint system is a rear-facing seat anchored only by the seat belt. Before the advent of passenger-side airbags, this infant seat could be used in the front passenger seat. After the advent of passenger-side airbags, the federal government mandated that all infant seats be labeled with a warning not use infant seats in the front seat of a vehicle equipped with passenger-side airbags.

In mid 1993, GAI started work on a rear-facing infant concept seat that would enable an infant to survive the infant seat/airbag interaction in the event of a "typical" collision. We first asked the question: "Could we design an infant seat for $500,000 that would work in concert with a passenger-side airbag without damaging the infant beyond routine exceptions?" We believed the answer was yes. We next proceeded in the manner of the famous anecdote: "Now that we know what we can do, how little do we think we can do it for?"

EVOLUTION OF THE MANDATE

The August 1994 Federal Mandate reads: "Warning: Place This Restraint In A Vehicle Seat That Does Not Have An Airbag."

Various studies led to this ruling. One completed by Ilrire Der Avanessian, Stephen A. Ridella, A. Mani and Prakash Krishnaswamy (SAE Paper 920126) simulated the effects of an airbag interacting with an infant in strapped in its infant seat in the front passenger seat of a vehicle. The simulationresults showed that airbag contact with the infant seat produced high infant dummy head acceleration; the airbag also produced considerably different infant seat kinematics (than without the airbag) and large motions that are not desirable.

Further studies by additional researchers (SAE Paper 933093) determined that no restraint system has reached the level of rear-facing child restraints without airbag interaction. They determined that rear-facing infant seats,

Chrysler will continue testing future GAI infant seat prototypes until ready for production, and Atoma has offered its design and testing services to help develop the new concept.

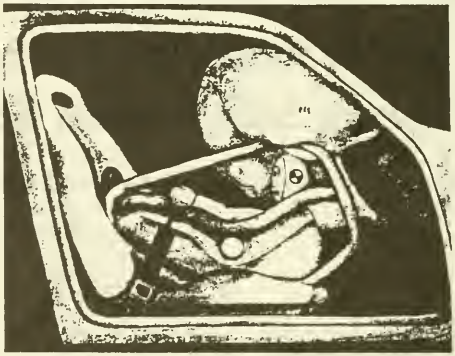
when properly used, are effective in frontal collisions, but not as effective in side collisions unless there is side impact protection. These researchers concluded that the "most alarming threat against widespread use of rearward facing child restraint systems is the installation of passenger-side airbags in new cars."

Kathleen Weber (SAE Paper 933094) conducted laboratory tests of infant seat and airbag interaction using a CRABI dummy and showed that a child could be seriously injured by the acceleration caused when the airbag deploys against the back of the infant seat. The primary cause of injury was high head acceleration accompanied with high chest acceleration. This occurs in the early part of the airbag inflation cycle.

Weber discusses a variety of possible "solutions," the most obvious being restricting the rear-facing infant seat to the rear passenger seat where there would be no infant seat-airbag interaction. In fact, this has been federally mandated (as discussed earlier in this article) but in practice probably does not work since there is nothing to keep a parent from putting the rear-facing infant seat in the front seat.

Another "solution" is to install a switch to turn off, manually or automatically, the passenger-side airbag. This is another false solution since it opens up a whole range of liability issues. One liability issue concerns total system reliability as you add elements to a system. Even if each element in the system has 99% reliability the overall system reliability decreases to 96%. No parent wants to take the chance that their child will be one of the three added infants to the one in one hundred that is killed or maimed because of system malfunction.

Another liability issue concerns vehicles without a usable rear seat, e.g. pickup trucks or sports cars. In what position is the passenger-side airbag switch when a driver, a passenger, and an infant (in an infant seat) are riding in the front seat of a pickup truck equipped with a passenger-side airbag. Is the switch placed in the "ON" position to protect the adult passenger, leaving the infant exposed to the possibility of injury in the event of an airbag deployment, or, is the switch placed in the "OFF" position thereby leaving the adult passenger in a vulnerable situation should an accident occur? Interestingly enough, the federal government wants to mandate a cutoff switch specifically for vehicles with no rear seat.



Artist's rendering of the airbag deployed in sled crash test conducted last December by Chrysler in conjunction with Atoma and GAI's XSCI division.

A third solution mentioned by Weber is to engineer an infant seat that "extends as much as possible the time and distance over which the infant occupant accelerates to reduce the acceleration level of its head and chest." The GAI infant seat does exactly this.

THE GAI SOLUTION

GAI has developed an infant seat that will not only keep infants as safe as possible, but it will be compatible with its most "natural" placing—rear-facing in the front passenger seat. A parent, when driving without another adult in the vehicle, will want the infant to be in sight in the front passenger seat.

Figure 1 is a photograph of a prototype GAI infant seat. The seat includes a head protector configured to deflect the forward facing portion of the seat downward upon interaction with the inflating airbag, while reducing the force per unit area in the region of airbag interaction. The infant occupied seat has a center of gravity that causes the belt retaining the seat to tighten for proper retention of the infant seat during the collision and subsequent airbag inflation. The forces generated by the collision (crash pulse) and the interaction of the inflating airbag with the infant seat are thus transferred to the vehicle seat. This transfer elongates the crash pulse while reducing its peak value.

In the GAI design, a plate integral with and mounted on tubing creates a large area in the back of the seat which is in the

path of the inflating airbag and helps spread the impact of the expanding airbag over a large area, so that unlike conventional infants seats, no high energy peaks are created. When hit, the tubing helps convert some of the straight-line energy to torque. The seat is pivoted in a way that an airbag impact pushes the back down and the front up, climbing on the back rest of the passenger seat. When the front of the infant climbs up, it also tightens the seatbelts and gets the seatbelt to absorb additional energy.

The concept seat provides for shock mounting the infant seat shell inside the backplate/tubing cocoon (the prototype seat seen in figure 1 is not shock mounted—one of its non optimizations). The concept seat also provides for a somewhat loose and flexible head restraint to keep a newborn's head from wobbling—again not equipped on the prototype seat. This head restraint will greatly reduce neck injuries.

In February 1994, GAI conducted crude tests on its first generation prototype to check for general survivability and determine a delta of the GAI concept over conventional infant seat design. Three baseline (no airbag simulation) tests were run for each configuration (GAI concept and conventional, off the shelf infant seat) using the GAI dummy. In all cases the dummy survived being exposed to less than 50 g even though the platform was subjected to about 56 g level impact. These first tests demonstrates that the dummy in either type of infant seat would not have been severely damaged in a frontal collision without a deploying airbag.

Three simulated airbag tests were then run for each configuration. Two types of engaging airbags were tried, one with tires (rubber with its elasticity to represent similarity to the plastic filled with air of an airbag) and the other wood (to check a near worst case approach where the airbag has little or no elasticity). Using either simulated airbag, the dummy in the conventional seat was pushed face first, into the back of the passenger seat and likely suffocated and/or suffered a broken neck.

On the other hand, the dummy in the GAI concept seat appeared to suffer no serious injury/damage, while being exposed to less than 50 g at the head. The rear of the infant seat in these cases was pushed upwards as designed, climbing up the backrest of the passenger seat.

THE CHRYSLER TEST

Upon demonstration of the feasibility of the GAI concept infant seat, GAI immediately submitted a patent application for this concept. Throughout the remainder of 1994 GAI worked on refining the design and developing a second generation prototype. Discussion with Chrysler in September 1994 led to a formal offer by Chrysler to test our prototype at no cost to GAI. Chrysler was especially interested in the GAI concept since Chrysler had performed its own in-house testing of conventional infant seats during 1991. Those conventional seats performed very poorly, convincing Chrysler that a real solution was necessary.

Chrysler also suggested to Atoma that it work jointly with GAI on the project (the GAI infant seat ties in well with the Atoma-developed integral child seat for the Chrysler minivan). Atoma took the GAI prototype infant seat, modified some of the materials (especially the tubing, substituting metal for PVC), and arranged for testing at the Chrysler Chelsea testing facility last December. Various personnel from Chrysler, Atoma and GAI witnessed the tests.

A Viper cockpit, as near worst-case scenario as possible, was used with a 6 month old CRABI dummy in the prototype infant seat. The test simulated a 30 mph () frontal impact. Twenty-nine telemetry channels of test data were acquired, with four channels dedicated to the dummies head, six to the upper neck, six to the lower neck, three to the chest, and three to the pelvis.

A single test was run, without room for readjusting or fixing any potential damage. The test results were astonishing: not only would the infant have survived unharmed, the crash pulse was greatly elongated (peak values were measured at more than 80 milliseconds)! The test video, especially when compared with the original Chrysler 1991 tests at the same test facility, demonstrated the enchanted survivability created by the GAI infant seat concept. Figure 2 shows an artist enhanced prototype of the GAI infant seat prototype in the Viper cockpit with the airbag deployed.

On January 5, 1995, less than three weeks after the tests at Chrysler, the U.S. Patent Office granted the patent application for the GAI infant seat. Chrysler has offered to continue testing any future infant seat prototypes until the infant seat is ready for production. Atoma has offered the services of its child seat engineering staff, design team, and testing lab required to develop the infant seat concept "for reasonable cost" for production. GAI through its Xportation Safety Concepts, Inc. (XSCI) subsidiary seeks collaborators to market its safety concepts. ■

(Editor's note: GA International will be participating in a roundtable discussion on safety during IA/ASBE '95—April 27th)

Investor's Business Daily
"The Newspaper For Important Decision Makers"
Thursday, September 14, 1995

The New America

KID GLOVES

Big Three May Deflate Airbags With New Toddler Safety Seat

By Paul A. Eisenstein
Investor's Business Daily

Unlike the safety seats used for toddlers, infant carriers are designed to face backwards when strapped in.

Unfortunately, that creates a potential hazard. When an airbag deploys, it fires with so much force it may strike the back of an infant's head, causing serious and sometimes fatal injuries.

As a result, carmakers now are required to post warnings in cars equipped with dual airbags advising parents to place infant carriers in the rear seat.

But that's not possible in two-seat sports cars and pickup trucks.

■

Automakers are toying with several ideas, including airbag cut-off switches and sensors. But a new infant safety seat may eliminate the problem altogether.

Developed by two Colorado inventors, the Goor Seat is designed to deflect the force of an inflating airbag away from a child.

The design has caught the attention of the safety experts at Chrysler Corp. They have provided extensive crash-testing without charge, and are seeking to help Dan and Pat Goor find a child seat manufacturer to put their concept into production.

"We're doing everything we can to encourage this ... in the spirit of advancing the safety of the children of the nation" said Ronald Zarowitz, Chrysler's manager of Vehicle Safety and Regulatory Affairs.

The Goor Seat already has one patent allowed and two others pending. Functionally, it can be used like a conventional infant safety seat, but there's one big difference. The cradle is isolated from the seat frame by a series of shock mounts.

■

"Basically, it's a cage that transfers the energy away from the child," said Pat Goor who, with husband Dan, runs Xportation Safety Concepts Inc., in Colorado Springs, Colo. The system has an added advantage. According to Goor, it also will protect the child if the seat is dropped.

The Goors established their firm eight years ago and have spent several years working on their infant seat, a process that already has cost them about $150,000. But they say it would have been difficult to prove out the design without Chrysler's help.

The automaker has run the Goor Seat through dozens of simulated collisions and airbag deployments. "We've had extremely good success with everything we've thrown at it so far," Zarowitz said.

There are still several challenges ahead.

Chrysler has "no interest" in going into child seat making, Zarowitz says, though the automaker has used its clout to connect the Goors to an existing manufacturer. Neither Chrysler nor the Goors will discuss details of the negotiations, though they both seem optimistic production could begin by 1996 or 1997.

■

Even if the inventors do find a manufacturer, they will have to convince the national Highway Traffic Safety Administration to allow them to advertise the claim that the Goor Seat can be used in the front seat of a car equipped with dual airbags. That process alone is likely to take months and may require extensive additional testing.

Consumer safety experts haven't had the chance to review the Goor design, but say they're certainly interested. "This is a better way to go —if it works," said Clarence Ditlow, director of the Washington-based Center for Auto Safety.

There's been mixed reaction to some of the other ideas proposed to solve the infant seat problem. Last month, Ford Motor Co. said it will equip its 1996 Ranger Pickup truck with an airbag deactivation switch. Designed to be used only when there's an infant safety seat in the two-seat vehicle, it temporarily shuts off only the passenger-side bag.

"It could be left in the off position when you have an adult there ... when you need it," Ditlow complained. "Any time you have a switch, it could fail."

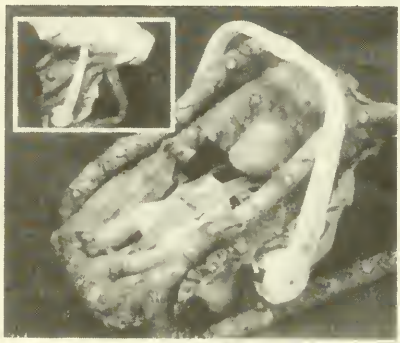
■

For those reasons, Chrysler has ruled out offering cut-off switches on its vehicles.

Officials approved the use of a cutoff switch only as an "interim measure," for use on passenger cars built until Sept. 1, 1997 and light trucks built before Sept. 1, 1998. After that, manufacturers would have to come up with another solution. Several are under study. A magnetic tag in an infant seat could be used to disable the passenger airbag or alter the way it deploys. An infrared or ultrasonic sensor could be used to distinguish between an infant seat and a regular, forward-facing toddler safety seat.

Such sensors might have added advantages, according to Zarowitz. Today's airbags are designed to protect passengers of all different sizes and weights, whether or not they are buckled up and no matter where they are sitting. A sensor would be able to determine a passenger's size and seating position.

But there would be added cost, however, and like a switch, sensors might fail occasionally, safety experts warn. That's why Zarowitz says he—and Chrysler—say something like the Goor Seat would still be needed.



The Goor Seat deflects the force of an inflating airbag away from a child

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